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THESIS

OPERATIONAL MANNING CONSIDERATIONS FOR SPARTAN SCOUT AND SEA FOX UNMANNED SURFACE VEHICLES (USV)

by

Matthew Richter

September 2006

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13. ABSTRACT (maximum 200 words)

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The methodology consisted of a literature review of USV test reports; USV Advanced Concept Technology Demonstration briefs; USV Concept of Operations; fleet lessons learned; the USV tactical memorandum; Naval manpower instructions, and manuals; Weapons Tactical, Field, and Training Manuals; Military Utility Assessments; search of books, magazines, and manpower theses.

The research found that determining manpower qualities and standard operating procedures will remain a dynamic process until USV equipment is standardized. The research also showed USV launch and recovery is more manpower intensive than that of a standard RHIB. Gunners Mates (GM) and Aviation Ordnancemen (AO) are potential source ratings to support USV Hellfire and Javelin missile modules. The Navy should establish a GM Navy Enlisted Classification (NEC) to support Hellfire and Javelin or add these weapons to existing GM NECs. Electronics Technicians (ET), Fire Controlmen (FC), and Fire Control Technicians (FT) are potential source ratings for USV electrical/electronic support. FC and FT are potential source ratings to support the Remote Operated Small Arms Mount. This research found additional warfighting capabilities can be gained by equipping surface warfare vessels with USV's without any negative effects to primary or secondary warfare missions. Overall, USVs enhanced designed capabilities of Naval warships and directly support a capabilities based Navy.

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ANALYSIS OF OPERATIONAL MANNING REQUIREMENTS AND DEPLOYMENT PROCEDURES FOR UNMANNED SURFACE VEHICLES ABOARD U.S. NAVY SHIPS

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LIST OF ACRONYMS AND ABBREVIATONS

AAW	Anti-Air Warfare
ACTD	Advanced Concept Technology Demonstration
AGM	Air to Ground Missile
AJ	Maritime Interdiction Operations Commander
AO	Aviation Ordnanceman
ASUW	Anti-Surface Warfare
ASUWC	Anti-Surface Warfare Coordinator
ASW	Anti-Submarine Warfare
AT	Anti-Terrorism
AT/FP	Anti-Terrorism and Force Protection
ATG	Afloat Training Group
C2	Command and Control
C3	Command, Control and Computers
CCOI	Close Contact of Interest
CG	Guided Missile Cruiser
CIC	Combat Information Center
CLU	Command Launch Unit
CNO	Chief of Naval Operations
CO	Commanding Officer
COI	Contact of Interest
CONOPS	Concept of Operations
CRUDES	Cruisers and Destroyers

CSG	Carrier Strike Group
DDG	Guided Missile Destroyer
EO	Electro-Optical
EO/IR	Electro-Optical Infra-Red
ESG	Expeditionary Strike Group
ET	Electronics Technician
FC	Fire Controlman
FP	Force Protection
FT	Fire Control Technician
GM	Gunners Mate
GPS	Global Positioning System
HVU	High Value Unit
I2R	Imaging Infra-Red
ISR	Intelligence, Surveillance and Reconnaissance
KSA	Knowledge, Skills and Ability
L & R	Launch and Recovery
LCS	Littoral Combat Ship
MIO	Maritime Interdiction Operations
MIW	Mine Warfare
MM	Millimeter
MUA	Military Utility Assessment
NAG	North Arabian Gulf
NEC	Navy Enlisted Classifications
NPS	Naval Postgraduate School

NSWC	Naval Surface Warfare Center
NTSP	Naval Training System Plan
NUWC	Navy Undersea Warfare Center
NVS	Night Vision System
NWDC	Navy Warfare Development Command
PIM	Plan of Intended Movement
OOD	Officer of the Deck
OJT	On the Job Training
OSS	Optical Sight System
PD	Point Defense
POE	Projected Operating Environment
PTZ	Pan, Tilt and Zoom
RC	Remote Control
RHIB	Rigid Hull Inflatable Boat
RF	Radio Frequency
RMP	Recognized Maritime Picture
RMV	Remote Minehunting Vehicle
ROC	Required Operational Capability
ROE	Rules of Engagement
ROSAM	Remote Operated Small Arms Mount
SMD	Ships Manning Document
SOF	Special Operations Forces
SOP	Standard Operating Procedure
SSC	Surface Search and Control

SUW	Surface Warfare
TACMEMO	Tactical Memorandum
TAO	Tactical Action Officer
TBD	To be determined
TSV	Theater Support Vessel
USA	U.S. Army
USMC	U.S. Marine Corps
USV	Unmanned Surface Vehicle
USW	Undersea Warfare
UUV	Unmanned Underwater Vehicle
VBSS	Visit Board Search and Seizure
XO	Executive Officer

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I. INTRODUCTION

A. AREA OF RESEARCH

The purpose of this research is to analyze existing operational manning of Unmanned Surface Vehicles (USV) on U.S. Naval Ships. The goal is to conduct follow on research to estimate manpower and personnel requirements through an analysis of knowledge, skills and abilities (KSA) to operate and maintain USVs assigned to fleet units.

B. RESEARCH QUESTIONS

1. Primary Questions

- What primary or secondary mission elements do USV operations support?
- What are the manpower implications they relate to weapon systems, maintenance, loading/unloading and delivery?
- What manpower qualities are required to launch and recover USVs?

2. Secondary Question

- What operational USV tactics exist and remain to be developed?

C. DISCUSSION

"Following the terrorist bombing of USS Cole and the CNO's "Deep Blue" Assessment, it became apparent that high value, blue water combatants in the littorals were at risk without enhanced defense and surveillance capability."[1] To counter mounting asymmetric threats to U.S. ships in the littorals the Navy is conducting fleet operational testing of unmanned surface vehicles (USV). USVs are not only expected to enhance host ship capabilities but also assist in providing a layered defense for surface ships. To complement the surface fleet as well as future combatants, the Navy is in the process of procuring unmanned surface vehicles (USVs). Though still in developmental phases, two USV platforms, SPARTAN SCOUT and SEAFOX, are the front runners for further fleet development.

Navy planners are not expecting the introduction of USVs to reduce manpower costs; in fact, initial analysis shows USVs to be more manpower intensive than standard Rigid Hull Inflatable Boats (RHIB). The real value of USVs is that they are able to

[1] Sea Fox Concept of Operations. NAVSEA Norfolk, June 2005.

perform several different types of missions without putting sailors directly into harms way and increase on-station time. USV projected mission areas include Maritime Interdiction Operations (MIO), Anti-Terrorism/Force Protection (ATFP), Surface Warfare (SUW), Anti-Submarine Warfare (ASW) in the littorals, Mine Warfare (MIW), SSC/RMP, Intelligence, Reconnaissance, and Surveillance (ISR), and Special Operations Forces (SOF) support. Although, U.S. Carrier Strike Groups have deployed with the SPARTAN SCOUT and SEAFOX USVs to conduct operational tests in theater, testing and development is still ongoing.

D. BENEFIT OF THE STUDY

USV operational manning considerations are only a starting point. If USVs are to eventually be fully integrated into service, this research will provide notional guidance for USV manning on future surface combatant platforms. In addition, research involving USV operational manning can be incorporated within the framework of the Total Force Manpower Concept.

E. SCOPE

The scope includes: (1) an examination of SPARTAN SCOUT and SEA FOX CONOPS, known/proposed tactics, fleet lessons learned messages, USV Management Plans, and USV test results; (2) a proposed USV SMD Watch Condition for USV operations, Launch and Recovery for surface combatants; (3) an evaluation of the Navy Enlisted Classifications (NEC) for Ship Manpower Documents (SMD) of USV host ships; (4) identify the need for USV operators to be experts in maritime navigation and rules of the road.

F. METHODOLOGY

The methodology used in this thesis research consisted of the following steps:

- Conduct a literature search of books, magazine articles, CD-ROM systems, test reports, Navy Lessons Learned, USV and Manpower theses, internet, SIPRNET, and other library information resources on the topic.
- An analysis of LCS manpower requirements concerning USV's.
- A qualitative analysis of U.S. Navy standards and policy regarding safe navigation and/or qualifications.
- An analysis of current Rigid Hull Inflatable Boat (RHIB) operating procedures.

- Review Spartan Scout Advanced Concept Technology Demonstration (ACTD) and Sea Fox concept of operations (CONOPS) documents.

G. THESIS ORGANIZATION

Chapter I: *INTRODUCTION*: Provides the purpose and a brief discussion of the thesis as well as the primary and secondary research questions.

Chapter II: *PRIMARY AND SECONDARY MISSION ELEMENTS SUPPORTED BY USV OPERATIONS.* This chapter discusses how the introduction of USV's to the fleet will enhance host ship Primary and Secondary Mission Elements.

Chapter III: *MANPOWER IMPLICATIONS OF USV WEAPONS SYSTEM ALTERNATIVES*: Considers the different levels of manpower required to support the various USV weapon systems such as .50 cal, Hellfire, Javelin, and GAU-17A (mini-gun). It will study the maintenance, loading/unloading, and delivery to be performed by naval personnel.

Chapter IV: *MANPOWER QUALITIES REQUIRED FOR GENERAL LAUNCH AND RECOVERY (L & R) OF A USV*: Focuses on the manpower qualities that are additional to the L & R of a standard Navy RHIB. Specifically, it concentrates on USV centric manpower qualities for C2 Pilots, Sensor Operators, Weapons handlers, and Electronics support.

Chapter V: *EXISTING AND PROPOSED OPERATIONAL TACTICS FOR USV MISSION AREAS*: This chapter explores the USV mission areas such as ATFP, MIO, SSC/RMP, ASUW, MIW, and Choke point transit.

Chapter VI: *SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS*: Lists the conclusion and thesis summary, and introduces recommendations for future thesis research.

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II. PRIMARY AND SECONDARY MISSION ELEMENTS SUPPORTED BY USV OPERATIONS

The proliferation of USVs across the fleet over the next few decades is expected to enhance overall maritime capability because it affords the Navy a force-multiplier at a relatively low-cost. Another crucial benefit is that USVs will transform what used to be a standard RHIB into multifaceted offensive and defensive force capability. In addition, the USV provides increased on-station time and minimizes the risk to personnel in dangerous maritime operations. Figure 1 is an example of a host ship's Required Operation Capability (ROC) by ship class. Fleet USV operations are intended to support several different primary and secondary mission elements. In particular, USV operations will support primary mission elements such as Anti-Surface Warfare (ASUW), Anti-Air Warfare (AAW), and Point Defense (PD). In addition, USV operations will support secondary mission elements such as Anti-Terrorism/Force Protection (ATFP), Maritime Interdiction Operations (MIO), Mine Warfare (MIW) and Surface Search and Control/Recognized Maritime Picture (SSC/RMP). Replacing the standard RHIB with USVs will transform the way the fleet currently conducts operations.

REQUIRED OPERATIONAL CAPABILITIES (ROC)
FOR
DDG-51 (ARLEIGH BURKE CLASS GUIDED MISSILE DESTROYERS

1. The DDG-51 Class destroyer's mission is to operate offensively in a high density multi-threat environment as an integral member of a Battle Group, Surface Action Group, Amphibious Task Force or Underway Replenishment Group to include striking targets along hostile shore lines. In addition it provides its own AAW, ASU and ASW self-defense and can effectively provide local shipping against subsurface, air and surface threats. The DDG-51 has the additional tasks of performing strike warfare, theater ballistic missile defense and missions of state. Accordingly, the following primary and secondary warfare mission areas are assigned:

AAW	AMW	ASU	ASW	CCC	C^2W	FSO	INT	MIW	MOB	MOS	NCO	STW
P	P	P	P	P	P	S	S	S	P	P	S	P

Figure 1. DDG-51 REQUIRED OPERATIONAL CAPABILITIES (ROC)[2]

[2] OPNAVINST 3501.311A. Required Operational Capabilities (ROC) and Projected Operational Environment (POE) for DDG-51(ARLEIGH BURKE) Class Guided Missile Destroyers. 30 June 1997.

A. PRIMARY MISSION ELEMENTS SUPPORTED BY USV

USV operations will support several host ship primary mission elements such as ASUW, AAW and PD. ASUW is a primary mission area that will be supported by USV operations. A USV with a Hellfire or Javelin module might be highly effective against Patrol Boats or small surface threats. However, the key limitation of the USV's capability to support ASUW is limited range. To maintain a quality data link, the USV must remain in a position approximately 5nm from the host ship.

A USV armed with a Hellfire or Javelin module can also support the host ship's AAW primary mission element. However, this support is limited to engaging only low-slow flying aircraft or helicopters. In the littorals or on the high seas, a USV that is tactically positioned along a threat bearing, 5nm forward of the host ship, will increase a Commander's options of engaging a low-slow flying aircraft.

Host ship Point Defense is another primary mission that is dramatically improved by USV operations. A USV, regardless of the weapons module (Hellfire, Javelin, .50 Caliber, 7.62 mm Minigun) can improve Point Defense in three ways. First, USV operations provide a highly mobile machine gun coupled with either a Hellfire or Javelin for sustained and credible Point Defense at sea. Second, a USV armed with Hellfire positioned 5nm from host ship is capable of engaging both air and surface contacts up to 11 nm from host ship. Third, a USV could help protect the host ship from asymmetrical swarm attacks in the littorals where host ships are most vulnerable. Overall, USV operations will support the ASUW, AAW, and PD primary mission elements.

B. SECONDARY MISSION ELEMENTS SUPPORTED BY USV OPERATIONS

USV operations also support secondary mission elements such as ATFP, MIO, MIW, and SSC/RMP. USVs have already been tested for military utility in Force Protection operations. In 2003, Spartan Scout USV successfully conducted FP operations in the basin at Mayport, FL. Later in 2003, USS Gettysburg used Spartan Scout USV for FP operations in Naples, Italy and Malaga, Spain. The FP operations consisted primarily of executing pre-designated way-point patrol routes and identification and classification of maritime contacts using the USV's organic sensor suite. In 2004, Spartan also conducted successful FP way-point patrols in Singapore. What makes USV's ideal for

FP is that the USV can remain on-station during watch turnover and that it eliminates the need for crew hotel services. Any of the recommended USV weapons modules (.50 Caliber, 7.62mm Gatling Gun, Hellfire, or Javelin) are highly capable of conducting FP operations.

In addition, Maritime Interdiction Operations (MIO) is another secondary mission area that will be significantly enhanced by USVs. One of the greatest risks of conducting MIO operations is putting our sailors into harms way. USVs will support MIO operations by using its Pan, Tilt, Zoom (PTZ) and Electro Optical Infra-red (EOIR) cameras to conduct a head count of the suspect crew. In addition, the USV can monitor the disengaged side of the suspect vessel, as well overboard discharges simultaneously. All of these actions can occur prior to disembarking the host ships Visit Board Search and Seizure (VBSS) Team on a standard RHIB. Figure 2 is sample video provided Spartan Scout USV, the image shows that a USV's video cameras are capable of monitoring activity on the disengaged side as well as overboard discharges.

Figure 2. Video Still Footage of USS GETTYSBURG (CG 64) via Spartan Scouts EO Camera[3]

[3] Mark Wasilewski, Spartan Scout ACTD Gettysburg Debrief, NUWC, 26 February 2004.

Another secondary mission element supported by USV operations is Mine Warfare (MIW). A Spartan Scout MIW USV is being designed exclusively to conduct MIW operations. This USV will be equipped with the AN/AQS-24 side scan sonar that provides both real-time acoustic data coupled and high resolution imagery for advanced mine detection in the littorals. This system combined with a host ships organic sensors and embarked naval air assets should increase the probability of successful mine detection.

Surface Search and Control (SSC) and Recognized Maritime Picture (RMP) are also secondary mission elements that are supported by USV operations. The Spartan Scout organic sensor suite consists of four fixed navigation cameras at 000, 090, and 270 degrees relative. In addition, it has a PTZ, EOIR camera, and radar. USV Command and Control (C2) Operators can use the USV's organic sensors for detection, identification, and classification of surface contacts.

Figures 3 and 4 are images taken from Spartan Scout USV's EO/IR Camera during the 2003 Military Utility Assessment in the Arabian Gulf. These images help to confirm the USV's capability to detect, classify, and identify surface contacts for effective SSC/RMP operations using its organic sensor suite.

Figure 3. Spartan Scout USV EO video footage of a Ferry[4]

[4] Wasilewski, Mark. Spartan Scout ACTD Gettysburg Debrief, NUWC, 26 February 2004.

Figure 4. Spartan Scout USV EO video footage of USS GETTYSBURG (CG 64)[5]

[5] Mark Wasilewski, Spartan Scout ACTD Gettysburg Debrief, NUWC, 26 February 2004.

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III. MANPOWER IMPLICATIONS OF USV WEAPON SYSTEM ALTERNATIVES

USVs offer a wide variety of remotely operated crew-served weapon systems capable in performing an array of Required Operating Capability (ROC)/Projected Operating Environment (POE) elements and statements. "USVs can employ a variety of modulated Hellfire, Stinger, 25-mm chain gun, 7.62-Gatling gun, dual or single .50 caliber machine guns, 40-mm grenade launchers, and a variety of non-lethal weapons."[6] Figure 5 is a "7 meter Intelligence, Surveillance, and Reconnaissance (ISR), Force Protection (FP) USV with an articulating weapons mount, a .50 caliber machine gun and an integrated Javelin missile that participated in the first successful "Live Fire" technical demonstration at the Aberdeen Test Center."[7] However, as the alternatives of weapons systems increase, the manpower requirements may follow.

Figure 5. Spartan Scout with .50 Cal and Javelin mount.[8]

6 Ricci, Vic. (2002), Spartan Scout Unmanned Surface Vehicle CONOPS, NUWC, July 2002.

7 Marvin, Ernest and Wasilewski, Mark. (2004), Unmanned Surface Vehicle Missión Module Development and Demonstrations, NUWC.

8 Marvin, Ernest and Wasilewski, Mark. (2004), Unmanned Surface Vehicle Missión Module Development and Demonstrations, NUWC.

Adding weapons systems such as Hellfire, Stinger, or Sea Javelin may add additional manpower qualities and/or requirements and billets as opposed to .50 caliber or GAU-17A Gatling Guns which are already supported by GM's attached to ships company. Whether or not ship's company can receive such specialized NEC's to support those systems and determining the need for new requirements is the emphasis of this chapter. In addition, it will determine and recommend the most efficient source code rating to provide maintenance and support for USV weapon system modules. From the start, it appears that Gunners Mates (GM) and/or Aviation Ordnancemen (AO) ratings would be the most qualified source ratings to maintain the various USV weapons modules.

A. REMOTELY OPERATED SMALL ARMS MOUNT (ROSAM)

The ROSAM is currently being evaluated for use on the Spartan Scout USV as well as the U.S. Army's Theater Support Vessel (TSV).[9] The ROSAM is the key component that provides Spartan Scout USV the capability to employ a variety of different weapon systems. The ROSAM's sighting system is comprised of both Forward Looking Infrared (FLIR) and an off-mount electro optical device. Its aiming system is made up of an optical, ring and post laser designator and laser range finder making it an effective fire control system for USV weapons modules.[10] The ROSAM's advertised maritime target detection range is rated at 4,400 yards.[11] As proven at Aberdeen, the ROSAM is a robust system that utilizes an optical target tracker, built-in fire control, and two-axis weapons correction stabilization in order to provide highly accurate maritime firepower.[12] The overall manpower implication to naval personnel is that the USV's ROSAM must be supported by shipboard personnel. Although the ROSAM has been issued the type classification MK49 MOD0 Gun Weapon System, no official NEC has been established for maintenance and support.

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[9] General Dynamics. U.S. Navy Type Classifies MK49 MOD0 Gun Weapon System. Dec 19, 2005. [retrieved June 27, 2006] available from world wide web @http:// www.gdatp.com/news/NR-019.htm.

[10] General Dynamics. U.S. Navy Type Classifies MK49 MOD0 Gun Weapon System. Dec 19, 2005. [retrieved June 27, 2006] available from world wide web @http:// www.gdatp.com/news/NR-019.htm.

[11] General Dynamics. MK49 MOD0. [retrieved june 27, 2006] available from world wide web @http://www.gdatp.com/products/weapons_systems/ROSAM/MK49.htm.

[12] General Dynamics. U.S. Navy Type Classifies MK49 MOD0 Gun Weapon System. Dec 19, 2005. [retrieved June 27, 2006] available from world wide web @http:// www.gdatp.com/news/NR-019.htm.

Figure 6. MK49 MOD0/ROSAM with M2HB Bushmaster .50 caliber machine gun[13]

Navy Fire Control Technicians have extensive experience with the Optical Sight System (OSS) associated with the MK86 GFCS on Ticonderoga Class Cruisers. In addition, Fire Control Technicians also maintain the MK46 MOD 1, OSS on Aegis Destroyers. The Navy has an established specialized NEC for fire control and optical sight systems. For example, NEC FC-1139 specializes in maintaining the OSS MK46 MOD 1. These FC's maintain both the GCS MK160 and the OSS MK46 MOD 1 on Aegis Destroyers. It is unclear if the current optics on the ROSAM/MK49 mount will reach fleet service as part of a dedicated USV weapons mount. However, what is clear is that Optical Sight Systems are not a new technology and therefore they are not expected to create a significant manpower hurdle for Navy Manpower Planning. Figure 7 is a description NEC FC-1139 taken from the Manual of Navy Enlisted Manpower and Classifications and Occupational Standards, Volume 2 (NECs).

[13] Vic Ricci, (2006), Spartan Scout ACTD USV Overview and Status, NUWC, 10 March 2006.

FC-1139 GCS MK 160 MOD 8/OSS MK 46 MOD1 Fire Control Technician

Performs planned and corrective maintenance on the Gun Computer System MK160 MOD 8 and Optical Sight System MK 46 MOD 1 of the Gun Weapon System MK 34 MOD 1 at the organizational and intermediate levels. Performs casualty analysis, fault detection/isolation, modular replacement, repair, test and alignment of individual equipment using Built-In-Test Capability. Operate the GCS Gun Console (GC) and OSS Control and Display (CDC) consoles and associated equipment in support of the ship's combat weapon system in a tactical situation and during test and evaluation.

Source Rating: FC	Billet Paygrade: E4-E8	Personnel Paygrades: E3-E9
Course: Mandatory	CIN: A-113-0125	CDP: 582L
Sequence Code: 4		NR Ind: R
Component NEC: 1120	Related NEC:	Open to Women: Yes
Primary Advisor: CNO N765	Tech Advisor: NAVSEA	ECM: PERS 4011D5

Figure 7. Description of FC-1139 MK160 MOD1/OSS MK 46 MOD 1 Fire Control Technician[14]

B. MANPOWER IMPLICATIONS FOR .50 CALIBER MACHINE GUN

The .50 caliber entered military service in 1921 and has been a proven combat weapon since WWII. It is still used by every branch of the U.S. military and scores of foreign militaries. Its simple yet effective design is the crux of its staying power. At 550 rounds per minute the M2HB Bushmaster .50 caliber will provide USV C2/Sensor operators with substantial fire power. A USV with a remotely operated .50 caliber weapons module will be a formidable addition to any Commanding Officers layered – defense architecture. However, the real benefit may be that adding the .50 caliber to the USV arsenal will not require additional manpower to support the weapon.

There are several reasons why there are no significant manpower implications associated with adding the .50 caliber to the USV arsenal. The first reason is that virtually every surface ship in the U.S. Navy is already equipped with a complement of .50 caliber machine guns. On many ships, the .50 caliber is the primary crew served weapon for point defense at sea. Second, because it is a crew served weapon, every ship already has a manpower requirement for Gunners Mates (GM's) and they are already proficient in loading and unloading the weapon. Figure 8 indicates GM occupational standards for maintaining and handling ship board small arms.

[14] NAVPERS 18068F. Navy Enlisted Manpower and Classifications and Operational Standards Manual. Vol. 2, NEC's. APR 2006

E. SMALL ARMS/SECURITY FORCES EQUIPMENT
E298 CONFIGURE RIFLES FOR USE AS LINE THROWING GUNS
E299 PERFORM MAINTENANCE ON LINE THROWING KITS AND ADAPTERS
E300 FIRE LINE THROWING GUNS
E301 STOW SMALL ARMS
E302 ISSUE SMALL ARMS
E303 INVENTORY SMALL ARMS
E304 FIELD STRIP, CLEAN AND INSPECT SMALL ARMS
E305 FIRE SMALL ARMS
E308 CONDUCT SMALL ARMS FAMILIARIZATION FIRINGS (FAMFIRE)
E309 CORRECT SMALL ARMS MISFIRES
E310 PERFORM SMALL ARMS PRE-FIRE AND POST-FIRE CHECKS
E311 STOW SMALL ARMS AMMUNITION
E312 ISSUE SMALL ARMS AMMUNITION
E313 INVENTORY SMALL ARMS AMMUNITION
E314 CLEAN, INSPECT AND TEST NIGHT VISION (NV) SIGHTS
E315 CLEAN, INSPECT AND TEST NIGHT VISION (NV) GOGGLES
E316 CLEAN AND INSPECT SHIP'S SELF DEFENSE FORCE (SSDF) AND VISIT, BOARD, SEARCH AND SEIZURE (VBSS) GEAR
E317 ISSUE SHIP'S SELF DEFENSE FORCE (SSDF) EQUIPMENT
E319 INSPECT PHYSICAL SECURITY EQUIPMENT
E324 INSPECT SMALL ARMS MAGAZINES AND ARMORIES
E326 LAUNCH PYROTECHNICS EQUIPMENT AND VISIT, GM-7

Figure 8. GM Occupational Standards for Small Arms[15]

Third, no additional training or specialized Navy Enlisted Classification (NEC) would be required because servicing and maintaining the .50 caliber is central to the GM rating. Therefore the knowledge, skills, abilities and shipboard infrastructure required to service and maintain the .50 caliber are already in place. Finally, the addition of a .50 caliber USV weapons module will not significantly impact the daily workload for shipboard GM's.

C. MANPOWER IMPLICATIONS FOR THE JAVELIN MISSILE SYSTEM

The Javelin anti-tank missile was developed by the U.S. Army. It is a shoulder-launched, fire and forget missile, with an imaging infrared (I2R) guidance system. "The Javelin consists of a missile in a disposable launch tube and a reusable Command Launch Unit (CLU) with a trigger mechanism and the integrated day/night sighting device for surveillance, and target acquisition and built-in test capabilities and associated electronics. The CLU, powered by a disposable battery, provides the capability for battlefield surveillance, target acquisition, missile launch, and damage assessment. The

[15] NAVPERS 18068F. Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards. Vol. 1, Navy Enlisted Occupational Standards. January 2004.

Javelin night vision sight (NVS) is a passive I2R system."[16] It also has an advertised effective range of approximately 2000 meters or about 2200 yards.

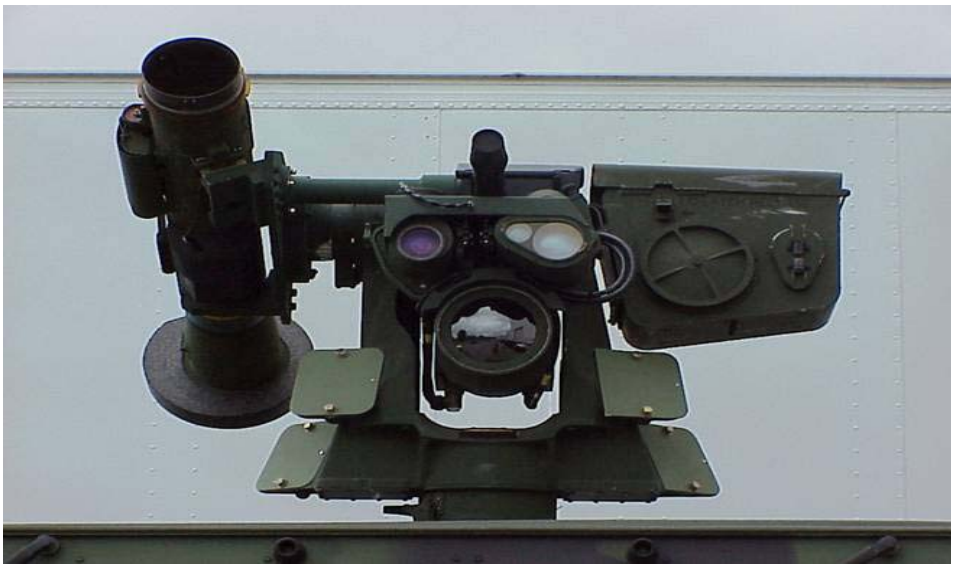

Figure 9. USV ROSAM Javelin/.50 cal mount[17]

Although the range of Javelin is limited, it is still a viable alternative for USVs. A USV equipped with Javelin will be a lethal weapon at sea, capable of ASUW, ATFP, and perhaps Anti Air Warfare (AAW) for low slow-flying aircraft. The sea borne application of the imaging infrared (I2R) guidance system is a good fit because the ocean provides a steady constant temperature to contrast a maritime target. Javelin is a fire and forget weapon, whereby USV C2 operators can launch the weapon and quickly maneuver to a safe position outside the target vessels weapons release range. However, at Aberdeen the Javelin Live-Fire testing was called off due poor platform stability issues.

In the Army, a Javelin gunner must complete Javelin Initial Training. This "initial gunner training is a prescriptive Program Of Instruction (POI) conducted at the institutions and in the unit. This training consists of two weeks of instruction culminating

16 Javelin Anti-tank Missile. [retrieved May 5, 2006] article available on world wide web @http://www.fas.org/man/dod-101/sys/land/javelin.htm.

17 Vic Ricci, Spartan Scout ACTD USV Overview and Status, NUWC, 10 March 2006.

in the successful completion of the Gunners Skill Test (GST)."[18] After that the soldier must maintain proficiency by taking Sustainment Training that is held in his unit on a monthly, bimonthly, quarterly, and annual basis. "Gunners must retain their skills by practicing engaging targets at least monthly. The gunner fires selected engagements from the monthly sustainment exercises using the Basic Skills Trainer (BST). The gunner practices field engagements using the Field Tactical Trainer (FTT) every other month. Once a quarter, the gunner completes the entire GST. If the gunner does not perform satisfactorily, he retrains until he qualifies."[19]

Currently the Navy has not established an official NEC associated with the Javelin because it is an Army/Marine Corps weapon system. Therefore, maintenance, loading/unloading and delivery are all manpower implications remaining unaddressed. There are three primary approaches; first, Navy personnel could attend USA/USMC sponsored Javelin training schools. Second, the Navy could incorporate Army Military Occupational Specialty (MOS) 45K Javelin System training into a similar NEC that already exists. Third, the Navy could create a new NEC.

The most likely source rating to apply Javelin training is GM because the Navy already has an established sub group of GM NEC's in which the Javelin could be easily incorporated. GM's with NEC's 0981 through 0991 already have a solid background in maintenance, loading and unloading of missiles on board ships. In addition, training and maintenance of the Javelin system is far less demanding for GM missile techs than the current organic naval missile systems they are accustomed to. Figure 10 is a description of GM NEC's 0981-0991.

[18] Army Field Manual. Javelin Medium Antiarmor Weapons System. FM 3-22.37. 23 January 2003.

[19] Army Field Manual. Javelin Medium Antiarmor Weapons System. FM 3-22.37. 23 January 2003.

GM-0981-0991 Guided Missile Launching Systems and Missile Maintenance Technician

Operates, inspects, and performs organizational and/or intermediate level maintenance on electric-hydraulic powered guided missile launching systems, missile equipment and explosive components. Prepares missile components and associated equipment for checkout and/or firing. Inspects and stows warheads, fuses, detonators and rocket motors. Installs explosive components in missiles and operates special handling equipment to transport missiles. Fuel missiles and service their pneumatic and hydraulic components and systems. Test and repair electrical control circuitry, electronic and magnetic amplifiers and power supplies, using standard and special test equipment. Personnel in pay grades E7 and above will supervise the foregoing, organize and monitor system test teams and instruct junior personnel in all aspects of their assigned equipment.

Figure 10. GM -0981-0991 Missile Maintenance Technician[20]

GM missile technicians with USA/USMC Javelin training will be more than capable of maintaining, loading and unloading a Javelin Missile for four reasons. The first reason is that ordnance/component maintenance is a central occupational standard of the GM rating as shown below in Figure 11.

ORDNANCE/COMPONENT MAINTENANCE

D237 CLEAN AND INSPECT MISSILES STOWED IN MAGAZINES
D239 PERFORM CLEANING AND PRESERVATION AFTER CASUALTY WET DOWNS
D240 PERFORM MISSILE CLEANING AND PRESERVATION AFTER LAUNCHING MISFIRES
D241 TREAT AMMUNITION AND COMPONENTS FOR CORROSION
D242 TREAT MISSILES AND COMPONENTS FOR CORROSION
D244 CLEAN AND INSPECT TEST MISSILES
D248 REPLACE GROUNDING PLUGS
D249 INSPECT MISSILE CONNECTIONS, FITTINGS AND MATING SURFACES
D293 SET PROJECTILE FUSING DEVICES
D294 INSPECT EXPLOSIVE ORDNANCE ITEMS FOR DAMAGE
D295 MARK DAMAGED EXPLOSIVE COMPONENTS
D296 DISPOSE OF DAMAGED EXPLOSIVE COMPONENTS

Figure 11. GM Occupational Standards for Ordnance/Component Maintenance[21]

[20] NAVPERS 18068F. Manual of Navy Enlisted Manpower and Classifications and Operational Standards. Vol. 2, NEC's. April 2006.

[21] NAVPERS 18068F. Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards. Vol. 1, Navy Enlisted Occupational Standards. January 2004.

Task: MAINTAIN A JAVELIN
Number: 071-060-0003
Effective Date: 2004-Mar-30

Enlisted MOS:	**STP:**
19D Skill Level 1	**STP 17-19D1-MIKE**
	STP 17-19D1-SM

Conditions: Given a Command Launch Unit (CLU), carry bag with all components, a CLU battery, a round of ammunition, a flashlight with batteries, a cleaning cloth, one ounce of detergent, one stiff bristle brush, one quart of water, one 2-quart pail, and Operator and Organizational Maintenance Manual for Javelin, TM 9-1425-688-12.

Standards: The CLU passes the operational check, all components are clean and free of corrosion. Supervisor is notified of any upper echelon deficiencies.

Performance Steps

Performance Measures	**GO**	**NO GO**
1. Inspected the CLU carry bag.	_____	_____
2. Inspected the CLU.	_____	_____
3. Performed CLU BIT.	_____	_____
4. Performed CLU operational check.	_____	_____
5. Removed battery.	_____	_____
6. Inspected the round.	_____	_____
7. Cleaned CLU and round.	_____	_____
8. Cleaned lenses.	_____	_____
9. Cleaned CLU/round interface connectors.	_____	_____
10. Cleaned battery compartment.	_____	_____

References:

Number	**Required**	**Title**

Certifications Required:	**None.**
Supporting Individual Tasks:	**None.**
Supported Drills:	**None.**

Figure 12. US Army Javelin Maintenance Checklist[22]

The second reason is that the Javelin was engineered with the infantryman in mind, therefore maintenance is minimal. Figure 12 is a US Army maintenance checklist borrowed from Army Training Manual TM 9-1425-688-12. It shows that Javelin maintenance consists primarily of inspecting and cleaning the CLU, checking the battery, and ensuring the system is free of corrosion. The third reason is that the stowing, loading and unloading of a single Javelin launcher on to a USV will not be a manpower intensive evolution due to its compact design. The fourth reason is that handling and stowing weapons is also a GM Occupational Standard. Figure 13 lists GM Occupational

[22] Army Training Manual. Operator and Organizational Maintenance Manual for the Javelin M98A1. TM 9-1425-688-12.

Standards for weapons handling and maintenance. As indicated, Gunners Mates Occupational Standards more than suffice to qualify personnel to conduct the loading, unloading, and stowing of Javelin missiles.

The final manpower implication to be addressed has to do with weapons delivery. This is where the Army/Marine Corps Javelin training falls short. The primary issue centers upon the fact that sailors will operate a remote maritime version of the Javelin mounted on a USV, as opposed to a traditional shoulder launch method used by infantrymen. Manpower planners must decide if C2 Pilot/Sensor Operators will receive the Javelin training to deliver ordnance on target, or if the GMs will fill the role as USV payload operators.

The Navy must decide whether or not to establish a Javelin NEC or if sending Sailors to USA/USMC Javelin training is currently sufficient. Also, the workload would greatly depend on the number of Javelin rounds available to USV operations. Once this is accomplished, the work hours associated with supporting the weapon system must be established and validated. The definitive answer of whether or not additional manpower requirements are required to support a Javelin system remains a Navy standard work week model determination.

C. WEAPONS HANDLING/MAINTENANCE

C185 MANEUVER WEAPONS
C189 CLEAN AND LUBRICATE WEAPONS HOISTS (HAND CHAIN, ELECTRIC, PNEUMATIC AND HYDRAULIC)
C190 TEST AND INSPECT WEAPONS HOISTS (HAND CHAIN, ELECTRIC, PNEUMATIC AND HYDRAULIC)
C191 ATTACH WEAPONS TO HOISTS
C192 INVENTORY ORDNANCE HANDLING TOOLS
C193 INSPECT MISSILE HANDLING EQUIPMENT
C194 UNPACKAGE MISSILES AND COMPONENTS
C195 PACKAGE MISSILES AND COMPONENTS
C198 CONDUCT ONLOAD OF MISSILES
C199 CONDUCT OFFLOAD OF MISSILES
C200 CONDUCT ONLOAD OF AMMUNITION
C201 CONDUCT OFFLOAD OF AMMUNITION
C202 STOW CONVENTIONAL MISSILES AND COMPONENTS
C203 STOW AMMUNITION (SEPARATED, FIXED AND SMALL ARMS)
C204 STOW PYROTECHNICS
C205 STOW DEMOLITION CHARGES AND COMPONENTS
C206 PREPARE ORDNANCE FOR UNDERWAY REPLENISHMENTS (UNREP) AND CONNECTED REPLENISHMENTS (CONREP)
C207 PREPARE ORDNANCE FOR VERTICAL REPLENISHMENTS (VERTREP)
C208 PERFORM ORDNANCE UNDERWAY REPLENISHMENTS (UNREP) AND CONNECTED REPLENISHMENTS (CONREP)
C209 PERFORM ORDNANCE VERTICAL REPLENISHMENTS (VERTREP)
C210 PREPARE ORDNANCE FOR SHIPMENT (PALLETIZE, CRATE, ETC)
C212 REPLACE ORDNANCE CONTAINER FASTENING HARDWARE GM-6
C214 PERFORM WEAPONS HANDLING EQUIPMENT OPERATIONAL TESTS
C215 PERFORM WEAPONS HANDLING EQUIPMENT POST MAINTENANCE OPERATIONAL TESTS
C216 REPAIR WEAPONS HANDLING EQUIPMENT
C221 CLEAN, INSPECT AND LUBRICATE WEAPONS ELEVATOR COMPONENTS
C222 PERFORM ELEVATOR OPERATIONAL TESTS
C223 REPLACE WEAPONS ELEVATOR COMPONENTS
C224 ADJUST WEAPONS ELEVATOR COMPONENTS
C225 REPAIR WEAPONS ELEVATOR COMPONENTS
C231 INSPECT LOADING AND STOWAGE PLANS
C547 STOW AND UNSTOW HANDLING GEAR
C548 OPERATE PALLET TRUCKS
C549 MAINTAIN PALLET TRUCKS
D. ORDNANCE/COMPONENT MAINTENANCE
D237 CLEAN AND INSPECT MISSILES STOWED IN MAGAZINES

Figure 13. GM Occupational Standards for Weapons Handling.[23]

[23] NAVPERS 18068F. Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards. Vol. 1, Navy Enlisted Occupational Standards. January 2004

D. MANPOWER IMPLICATIONS FOR THE HELLFIRE MISSILE (AGM-114A)

The Hellfire missile is a semi-active laser guided, subsonic anti-tank missile. The Hellfire has an effective range of over 6nm. Hellfire missiles are commonly used by Navy SH-60/HH-60 helicopters for ASUW operations. Originally designed as an air-to-surface missile, the Hellfire has evolved into a quality air-to-air weapon used to engage helicopters or slow moving fixed wing aircraft. The Hellfire can be guided to its target by a laser provided by either the helicopter or a shipboard MK80 Illuminator.[24] USV's armed with Hellfire missiles would be a formidable asset capable of effective ASUW or ATFP operations. In addition, USVs with Hellfire would provide a quality buffer for a HVU during a strait transit scenario.

Figure 14. HELLFIRE MISSILE (AGM-114A)[25]

When SH-60/HH-60 Helicopter Detachments deploy with ships, they bring the Hellfire with them. The Aviation Ordnancemen (AO) assigned to the Helo Detachments for the maintenance, loading and unloading of all air launched weapons, including the Hellfire. However, GMs also have experience in handling Hellfire missiles on ships. If Hellfire is to become a USV weapons module, the fleet must decide if the AO and/or GM ratings will provide the manpower to support it. Currently, the Aviation Ordnance NEC AO-6801 is dedicated to performing fleet intermediate maintenance ashore and at sea for

[24] U.S. Navy Official Website. FACT FILE. [Retrieved May 31, 2006] available on world wide web @http://www.navy.mil/navydata/fact_display.asp.

[25] Google.com. HELLFIRE Image. [retrieved May 31 2006] available from world wide web @http://en.wikipedia.org/wiki/Image:Hellfire_AGM-114A_missile.jpg.

all air launched weapons.[26] Figure 15 is a description of the AO-6801 NEC from Volume 2 of the Navy Enlisted Manpower and Classifications and Operational Standards Manual.

AO-6801 Air Launched Weapons Technician

Performs fleet intermediate level maintenance ashore and afloat on all air-launched weapons in accordance with the Naval Airborne Weapons Maintenance Program (NAWMP) and within the explosive safety rules and regulations of NAVSEA OP4, OP5, OP2165, and OP3565.

Source Rating: AO	Billet Paygrades: E3-E7	Personnel Paygrades: E3-E7
Course: Mandatory	CIN: C-646-7007 (P/L)	DCP: 555C, 560H, 569A, 432W
Sequence Code:5		NR Ind: R.
Component NEC:	Related NEC:	Open to Women: Yes
Primary Advisor: CNO N789	Technical Advisor: NAVAIR	ECM: PERS 4011D1

Figure 15. Description of NEC AO-6801 Air Launched Weapons Technician[27]

At this point, CRUDES ships do not have a manpower requirement for AO's. However, creating billets for AO's on CRUDES ships to support a Hellfire USV weapons module is not the best solution because most surface combatants GM's requirements have the Missile Maintenance Technician NEC's per their Ships Manning Document (SMD). A viable solution would be to simply add or change the source rating code to GM for HELLFIRE. With some training, these GM missile maintenance technicians will be more than capable of maintaining, loading and unloading these weapons. In addition, Hellfire will no longer be used as an air launched weapon. It will evolve into a surface-to-surface or surface-to-air missile when mounted on a Spartan or Sea Fox USV.

Making the determination on whether AO's or GM's maintain, load and unload the Hellfire USV module may depend on how the Navy chooses to organize USV assets. From the outset the Navy has two clear options for organizing USV assets. The first option would be to stand up USV Squadrons that would deploy as Operational Sea

[26] NAVPERS 18068F. Manual of Navy Enlisted Manpower and Classifications and Operational Standards. Vol. 2. NEC's. APR 2006.

[27] NAVPERS 18068F. Manual of Navy Enlisted Manpower and Classifications and Operational Standards. Vol. 2. NEC's. APR 2006.

Detachments to ships entering a theater of operations. If the Navy chose this option, it could assign AO's or GM's to USV Squadrons to support a USV Hellfire weapons module, because both ratings are already familiar with the weapon. Therefore a new NEC would not have to be established. The Navy would only have to add manpower requirements for AO's or GM's to USV Squadrons. The second option for USV organization would be to assign USVs to surface combatants to replace standard rhib boats as organic assets. In this scenario it is doubtful AO's would be assigned to ship's company. Primarily because GM's with the Missile Maintenance Technician NEC are already in place. Although these GMs are lacking explicit Hellfire training, this obstacle can be overcome. GM's can attend Hellfire specific training to close the training gap.

Like the Javelin, the real manpower implication associated with the Hellfire has less to do with maintenance, loading and unloading; and more to do with weapons delivery. On USS GETTYSBURG in 2003, two surface warfare officers were assigned to operate SPARTAN SCOUT. One officer was responsible for C2/piloting the USV, the second officer operated the SPARTAN's organic sensors such as Radar, PTZ and EOIR cameras. As weapon systems are added to USV's, a decision must be made who will control the USV weapons suite. USV Operators will have to attend training for both the Hellfire and Javelin in order to effectively the USV weapon modules.

E. MANPOWER IMPLICATIONS FOR THE GAU-17A, 7.62MM GATLING GUN

The GAU-17A Gatling Gun is an effective combat weapon that is typically mounted to aircraft. It is "air-cooled, multi-barreled and electrically powered with a firing rate up to 3,000 rounds per minute."[28] A USV with a GUA-17A ROSAM mount would be an effective ATFP platform. Like the .50 caliber, the benefit of adding the GAU-17A to the USV arsenal is that it will not require additional manpower to support the weapon because it is a crew served weapon on surface combatants. If the Navy uses the GAU-17A as a USV weapons module it will have no significant manpower implications with regards to maintenance, loading/unloading and delivery.

[28] Army Technology.com. [retrieved May 31, 2006] available from world wide web @http://www.army-technology.com/projects/uh_1y/.

Figure 16. GAU-17A fired from CG[29]

[29] WIKIPEDIA Online Encyclopedia. Minigun Image from USS Philippine Sea. [retrieved June 11, 2006] available form world wide web @http://en.wikipedia.org/wiki/Image:Gau_17_7.62mm_minigun.jpg.

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IV. MANPOWER QUALITIES REQUIRED FOR GENERAL LAUNCH AND RECOVERY OF A USV

The focus in this chapter is on USV centric manpower qualities additional to those required to successfully launch and recover (L & R) a standard RHIB. These additional USV manpower requirements include C2/Sensor Operators and technicians, sensor suite pre-launch checks and weapons technicians to load, unload and maintain weapons systems. In a Naval Postgraduate School thesis, LT Wayne Gayle (table 1) illustrates additional requirements to launch and recover a USV as opposed to a standard RHIB. However, the table differs because the L & R of the USV for DDG's 91-96 is not a true USV, it is a small semi-submersible Remote Minehunting Vehicle (RMV).

LAUNCH AND RECOVERY		
Host Ship	**RHIB**	**USV**
Pearl Harbor	15	20
Gettysburg	11	18
DDG 91-96	9	4

Table 1. L & R Personnel Numbers[30]

The additional manpower qualities will certainly require a different mix of rates to support the USV. This can be accomplished by selecting compatible source ratings. Once manpower requirements and qualities are established, training and standard operating procedures can be developed. In 2003, USS GETTYSBURG sailors successfully demonstrated dozens of USV L & R's at sea. Later in 2005, USS Pearl Harbor sailors successfully launched and recovered the Sea Fox USV while underway. In both cases NUWC, NWDC or NAVSEA civilians provided USV L & R training to sailors on station because each USV and host ship was different. As USVs progress towards fleet service, Standard Operating Procedures (SOP) and USV L & R methods

[30] Wayne Gayle, Analysis of Operational Manning Requirements and Deployment Procedures for Unmanned Surface Vehicles aboard US Navy Ships. Master's Thesis, Naval Postgraduate School, March 2006.

evolve at a similar rate as USV's. Therefore, it is somewhat unrealistic to expect uniformity in procedures until a standard USV is assigned to the fleet.

A. MANPOWER QUALITIES REQUIRED FOR USV ELECTRONICS PRE-LAUNCH CHECKS

The final remote Command and Control electronics, weapon systems modules, communications and sensor suite to be installed on USVs are still under development. Therefore, determining manpower qualities is a dynamic process until standardized equipment is agreed upon and installed. Regardless of what the final systems may be, the Navy is still capable of establishing some generalized manpower qualities for USV C2 and sensor suite pre-launch checks. At a minimum, sailors conducting pre-launch checks on USV electronics must possess the following manpower qualities:

USV RADAR SYSTEMS

- TROUBLESHOOT, ADJUST, ALIGN, TEST, OPERATE, MAINTAIN AND REPAIR, AND REPLACE USV RADAR EQUIPMENT
- EVALUATE PERFORMANCE OF USV RADAR EQUIPMENT
- CLEAN AND INSPECT USV RADAR EQUIPMENT
- TROUBLESHOOT, ADJUST, ALIGN, TEST, OPERATE, MAINTAIN AND REPAIR, AND REPLACE USV RADAR ANTENNA SYSTEMS
- EVALUATE PERFORMANCE OF USV RADAR ANTENNA SYSTEMS
- CLEAN AND INSPECT USV RADAR ANTENNA SYSTEMS

USV NAVIGATION SYSTEMS

- TEST AND OPERATE USV GLOBAL POSITIONING SYSTEM (GPS) EQUIPMENT
- EVALUATE PERFORMANCE OF USV GPS EQUIPMENT

USV COMMUNICATION SYSTEMS

- TROUBLESHOOT, ADJUST, ALIGN, MAINTAIN, REPAIR, AND REPLACE USV VHF/UHF TRANSMITTER/RECEIVER
- EVALUATE PERFORMANCE OF USV VHF/UHF TRANSMITTER/RECEIVER
- CLEAN AND INSPECT USV VHF/UHF TRANSMITTER/RECEIVER
- ANALYZE RESULTS OF USV DIAGNOSTIC MAINTENANCE

USV ELECTRICAL/ELECTRONIC MAINTENANCE

- TROUBLESHOOT, ADJUST, ALIGN, AND REPLACE COMPONENTS ON USV POWER SUPPLIES

- TEST, MAINTAIN, REPAIR, CLEAN AND INSPECT USV POWER SUPPLIES
- INSPECT USV ELECTRONICS AND ANTENNA SHOCK MOUNTS
- REPLACE GASKETS AND "O" RINGS
- INSPECT USV CABLE CONNECTIONS FOR CORROSION, CRACKS, DAMAGE, OR WEAR)
- TREAT USV ELECTRONIC CONNECTIONS FOR CORROSION PREVENTATIVES

USV VIDEO EQUIPMENT

- CLEAN AND INSPECT PTZ, EO/IR AND FIXED NAV CAMERAS
- ADJUST AND ALIGN PTZ, EO/IR AND FIXED NAV CAMERAS
- TROUBLESHOOT AND MAINTAIN PTZ, EO/IR AND FIXED NAV CAMERAS
- TEST AND EVALUATE AN TILT ZOOM PTZ, EO/IR AND FIXED NAV CAMERAS

ET's are the Navy's shipboard experts in testing, troubleshooting and maintaining radar systems, navigation systems, radio communication suites, video equipment and data links. The occupational standards for an ET3 are listed in Appendix A. After a brief review of an ET3's occupational standards, it is evident that the manpower qualities associated with conducting effective USV C2 and sensor suite pre-launch checks are closely aligned with the occupational standards of Navy Electronics Technicians (ET). In addition, ET's have already proven their ability to successfully support a USV in an operational environment. In 2003, USS GETTYSBURG used ET's to conduct pre-launch checks and maintenance on Spartan Scout USV's C2 and sensor suite during its Military Utility Assessment in the Arabian Gulf.

However, ET's are not the only shipboard rate capable of conducting these checks. FC's and FT's also have a background in testing, inspecting, troubleshooting and maintaining maritime electronics associated with navigation and radar systems, RF communication suites, data links and fire control systems. There are strong parallels in the Navy occupational standards between ET's and FC/FT's. FC3 and FT3 occupational standards are listed in Appendices B and C. Like ET, FC and FT occupational standards also include electrical/electronic maintenance and radar maintenance. Therefore, FC and FT may also be viable shipboard source ratings capable of conducting USV C2 and sensor suite pre-launch checks.

B. WEAPON SYSTEMS MANPOWER QUALITIES REQUIRED FOR USV L & R

Gunners Mates (GM) and Aviation Ordnancemen (AO) have extensive fleet experience in missile handling and maintenance. However, FC's and FT's also have experience in weapons handling and are also a potential source rating for USV weapons modules. In addition, FC's or FT's are the first choice in maintaining the MK49 MOD 0, ROSAM mount. The weapons systems manpower qualities required for USV L & R include:

USV MK49 ROSAM MOUNT

- TEST AND INSPECT MK49 MOD 0, ROSAM MOUNT
- ADJUST AND ALIGN MK49 MOD 0, ROSAM MOUNT
- TROUBLESHOOT AND MAINTAIN MK49 MOD 0, ROSAM MOUNT

USV .50 CALIBER WEAPONS MODULE

- TEST AND INSPECT .50 CALIBER MACHINE GUN
- TROUBLESHOOT AND MAINTAIN .50 CALIBER MACHINE GUN
- LOADING/UNLOADING AND SAFE STOWAGE OF .50 CALIBER MACHINE GUN

USV GAU-17A WEAPONS MODULE

- TEST AND INSPECT GAU-17A GATLING GUN
- TROUBLESHOOT AND MAINTAIN GAU-17A GATLING GUN
- LOADING/UNLOADING AND SAFE STOWAGE OF GAU-17A GATLING GUN

USV HELLFIRE WEAPONS MODULE

- TEST AND INSPECT HELLFIRE MISSILE
- TROUBLESHOOT AND MAINTAIN HELLFIRE
- LOADING/UNLOADING AND SAFE STOWAGE OF HELLFIRE MISSILE

USV JAVELIN WEAPONS MODULE

- TEST AND INSPECT HELLFIRE MISSILE
- TROUBLESHOOT AND MAINTAIN HELLFIRE
- LOADING/UNLOADING AND SAFE STOWAGE OF HELLFIRE MISSILE

C. USV C2/SENSOR OPERATOR MANPOWER QUALITIES REQUIRED FOR L&R

C2 and sensor operators are essentially the most vital part of the USV team. To effectively operate a USV, the C2 pilot and Sensor operator must work in tandem to

maintain the maritime picture. C2 pilots are responsible for the safe maneuvering via way-point route, as well as the safe navigation of the USV. The C2 Pilot must also have a keen awareness of the tactical picture at all times. USS Gettysburg (CG-64) employed Surface Warfare Officers as C2 pilots and sensor operators. This provided the NUWC civilians and the ship's CO with the assurances that the C2 and Sensor Operators were well versed in rules of the road and contact avoidance. However, there are enlisted ratings that are subject matter experts in maritime contact avoidance, safe navigation and the nautical rules of the road. USV C2 and Sensor Operators is not necessarily the exclusive realm of Surface Warfare qualified officers. The decision of whether Officers or Enlisted personnel should assume these positions must be carefully examined. At a minimum, USV C2 Pilots should possess the following manpower qualities and competencies:

- Subject matter expert in all USV C2 training requirements
- Subject matter expert in the coordination, integration, planning, and briefing of USV operations at sea
- Subject matter expert in all USV systems, functions
- Subject matter expert in USV tactical capabilities and limitations
- Subject matter expert in employment of all USV weapons modules and applicable Rules of Engagement
- Subject matter expert in all facets of USV Launch and Recovery
- Ability to pass control of USV to and from RC operator
- Knowledge of RF C2 and Data Link cut-outs in vicinity of host ship
- Knowledge and ability to operate, analyze, and develop a clear tactical picture by utilizing all USV sensors data
- Ability to execute various MIW Survey Patterns via GPS Way-point navigation
- Ability to execute various USV tactical maneuvers
- Knowledge of RF Data links and fundamentals RF communications
- Knowledge and understanding of GPS
- Subject matter expert in remote responses to USV casualties
- Effective and Safe operation and navigation of USV at sea
    - Knowledge and understanding of COLREGS and Rules of the Road

- Ability to safely navigate USV using all organic cameras
- Ability to safely navigate USV via GPS way-point routes using USV C2 software
- Ability to safely navigate USV in various sea states and weather conditions
    - Ability to determine significant environmental changes and safe operating environment using organic cameras
- Ability to safely navigate USV in a degraded RF link environment with significant signal latency
- Excellent knowledge of time and distance problem solving
- Excellent understanding of relative motion and contact avoidance

The Sensor Operator is responsible for maintaining the both the radar and tactical picture. USV Operations must maintain continuous close coordination with the SSUWC, TAO and OOD. The following are the minimum manpower qualities required of a USV Sensor Operator:

Ability to detect, track, identify, and classify surface contacts using all USV organic sensor suite

Subject matter expert in all USV systems and functions

Subject matter expert in all facets of safe L & R of USV

Ability to Operate EO/IR and PTZ Cameras

- Ability to maintain video coverage at various speeds, sea states, and operating conditions
- Ability to maintain video coverage in a degraded RF link environment with significant signal latency

Operate RF Data Links

Knowledge of fundamental of RF communications

Knowledge of RF C2 and Data Link cut-outs in vicinity of host ship

Basic understanding of sound propagation and sonor theory

Ability to effectively operate AN/AQS-24 side scan sonar system

- Ability to locate underwater threats
- Ability to execute object avoidance

Subject matter expert in the safe operation and employment of USV Weapons modules

- Knowledge of CAPS and LIMS, tactical employment, and ROE of Hellfire weapons module
- Knowledge of CAPS and LIMS, tactical employment and ROE of Javelin Weapons Module
- Knowledge of CAPS and LIMS, tactical employment and ROE of GAU-17A Weapons Module
- Knowledge of CAPS and LIMS, tactical employment and ROE of .50 Caliber Weapons Module
- Knowledge of CAPS and LIMS of MK49 MOD 0 ROSAM Fire control system

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V. EXISTING AND PROPOSED OPERATIONAL TACTICS FOR USV MISSION AREAS

The possibilities for USV mission areas are relatively wide. The "offensive and defensive capability and force protection will be provided through USV weapons and sensors, and capabilities in well as supporting and supported platforms capabilities, such as warfare AAW, ASW, ASUW/precision strike, or mutual support or overlapping fields of fire, if required."[31] However, with the exception of NAVY TACMEMO 3-22-5-SW sparse literature exists on USV operational tactics. This chapter discusses existing and proposed operational tactics for the major USV mission areas.

A. ANTI-TERRORISM AND FORCE PROTECTION (ATFP)

Force Protection is a mission area where the implementation of USV's can help transform the Navy. One of the benefits of the USV is its ability to remain on station during watch turnover reducing the window of opportunity for small boat attacks. "USVs can provide force protection for as long as they are supported by the supporting infrastructure or mother ship."[32] This factor alone will enhance the host ships defenses in port when it is most vulnerable. Another major benefit is that "unmanned vehicles can conduct early warning perimeter patrols or disrupt a sea-borne attack against naval units. As a part of layered defense architecture, UVs can provide awareness regarding emergent activity surrounding the high value unit."[33] During the military utility assessment on USS GETTYSBURG in 2003, Spartan Scout USV successfully demonstrated its Force Protection capability to patrol pre-designated way-point routes in and around the Mayport basin.

When blue water naval vessels are moored or at anchor, USV organic sensors will detect, track, identify, target and even engage small boats that threaten the host ship. In addition to radar, PTZ and EOIR cameras at their disposal, C2 operators can conduct queries and warnings to small boats via the USV's loud hailer. However, the biggest challenge that USV operators have to overcome is how to determine what constitutes

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[31] Vic Ricci, Spartan Scout Unmanned Surface Vehicle CONOPS, NUWC, July 2002.

[32] Vic Ricci, Spartan Scout Unmanned Surface Vehicle CONOPS, NUWC, July 2002.

[33] NAVY TACMEMO, Integration of Unmanned Vehicles into Maritime Missions, TM 3-22-5-SW.

hostile intent. USV C2 operators/pilots must be cognizant of current threat conditions, set and drift, tidal considerations, local commercial shipping, and expected ship movements.

Once a contact is positively identified as hostile, "USV's can interrupt the progress of like-sized boats, break-up formations, and serve as an obstacle."[34] The USV can be used to either engage or shoulder a given threat. Figure 17 illustrates a notional USV tactic to intercept and thwart a small boat attack on a HVU.

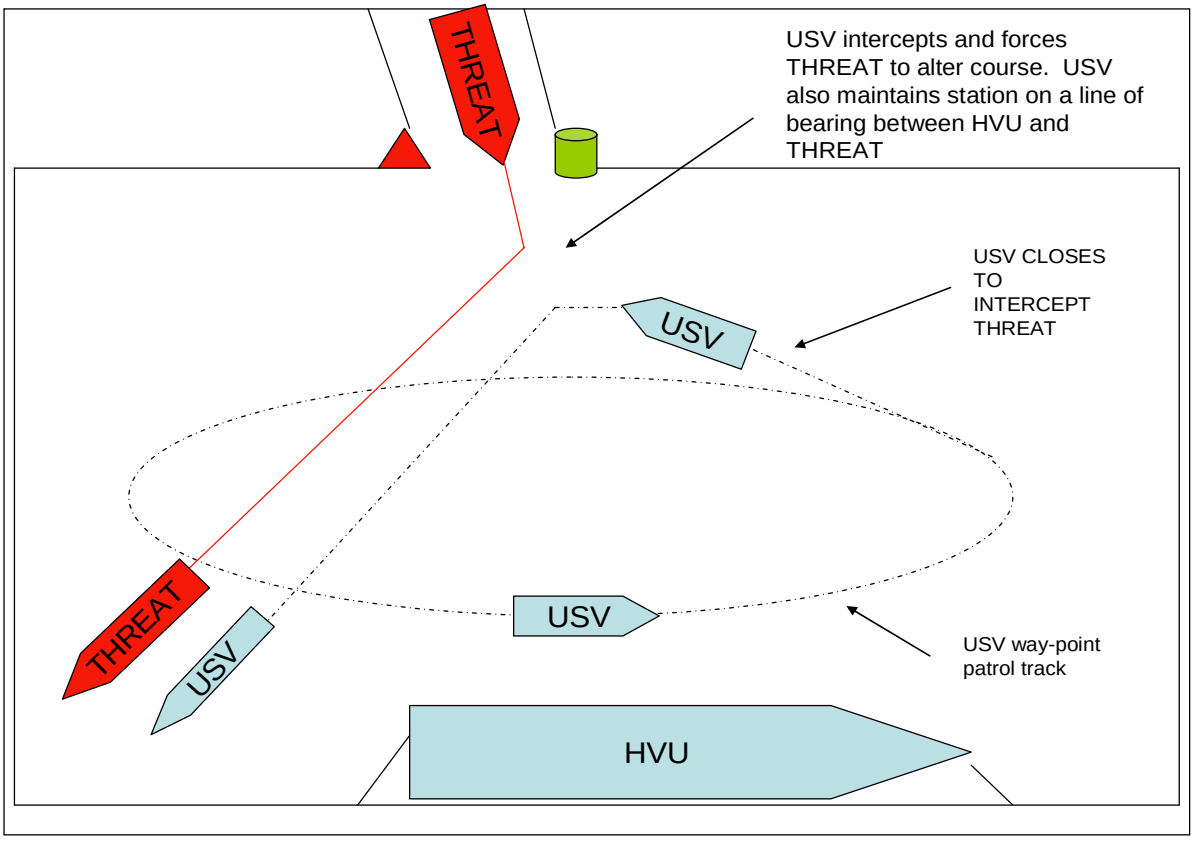

Figure 17. NOTIONAL USV INTERCEPT TACTIC

C2 operators close to intercept the threat at high speed to show willingness to defend HVU. The intent is compel the hostile to alter course to avoid collision. The

[34] NAVY TACMEMO, Integration of Unmanned Vehicles into Maritime Missions, TM 3-22-5-SW.

USV will maintain position in a line of bearing between the HVU and the hostile contact while diverting the contacts course away from the HVU.

B. MARITIME INTERDICTION OPERATIONS (MIO)

USVs will play an integral role in future MIO operations. USVs can be used to perform the "Horseshoe Maneuver." Once the MIO Commander (AJ) and the CO make determination to board a suspect vessel, the USV will be outfitted with .50 Caliber or GAU-17A weapon module. C2 operators will dispatch the USV to conduct the Horseshoe maneuver. Operators will use EOIR and PTZ cameras scan the forecastle of the suspect vessel to perform the head count of the crew. Maintaining a safe distance the USV will take station 200 yards off the beam of the disengaged side of the suspect vessel and monitor top side activity and overboard discharges. Figure 18 illustrates a notional horseshoe maneuver to be conducted by the USV.

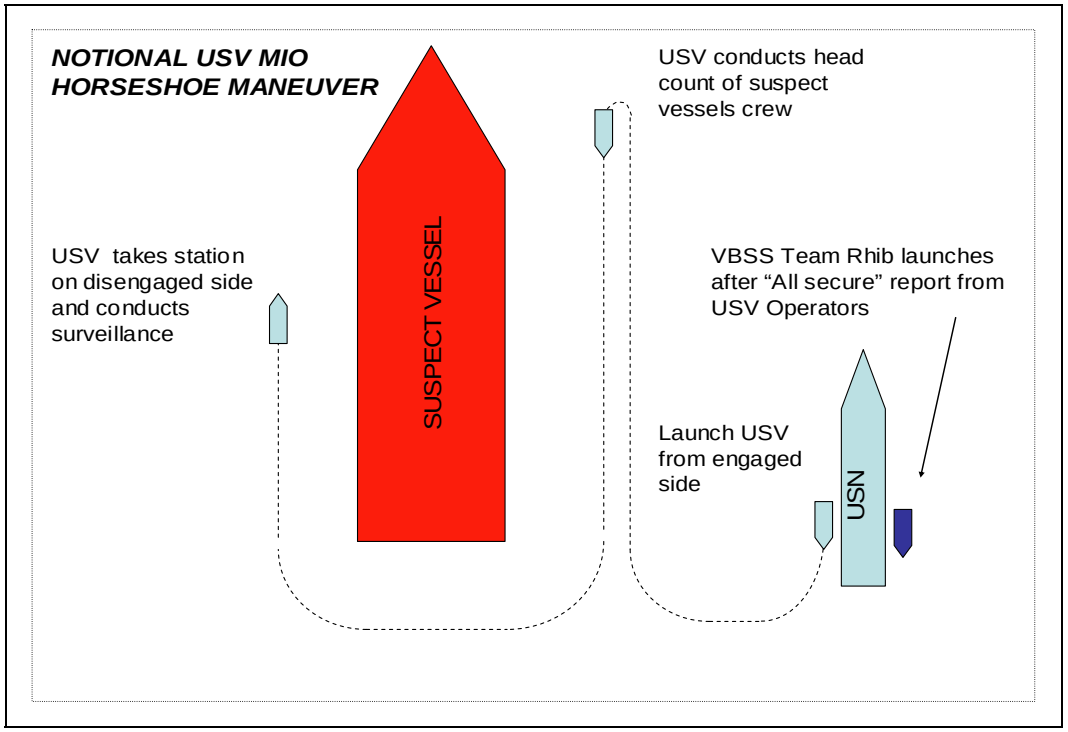

Figure 18. Notional MIO Horseshoe Manuever with USV

Throughout the boarding the USV will provide real time surveillance of the disengaged side of the suspect vessel, improving the security of our boarding teams. If extra equipment, personnel, or supplies are needed, the USV can act as a shuttle. Once

the USV is in position, the host ship SNOOPY team will maintain visual contact with the ships crew and continuously monitor suspect vessel from the engaged side of the suspect vessel. The VBSS Boarding Officer will not cast off until C2 operators report to the TAO and OOD that "All crew members accounted for," and "Disengaged side of suspect vessel is all secure."

C. SURFACE SEARCH AND CONTROL (SSC) AND RECOGNIZED MARITIME PICTURE (RMP)

The SSC and RMP mission area is significantly restricted due to current operational range limitations. During the 2003 MUA conducted in the North Arabian Gulf (NAG), Spartan Scout USV demonstrated its ability to perform the SSC/RMP mission within 6nm of USS GETTYSBURG. In reality, a USV with a 6nm reliable sensor range does not really improve a naval vessels SSC/RMP capability. At such a limited range the host ship will depend less on a USV's ability to detect a contact, rely heavily on the USV's ability to provide overt ISR. Figure 19 illustrates Spartan Scout's sensor range limitations experienced during the 2003 military utility assessment in the Arabian Gulf. As indicated, Spartan's full sensor suite reliability was limited to 6 nm from USS GETTYSBURG.

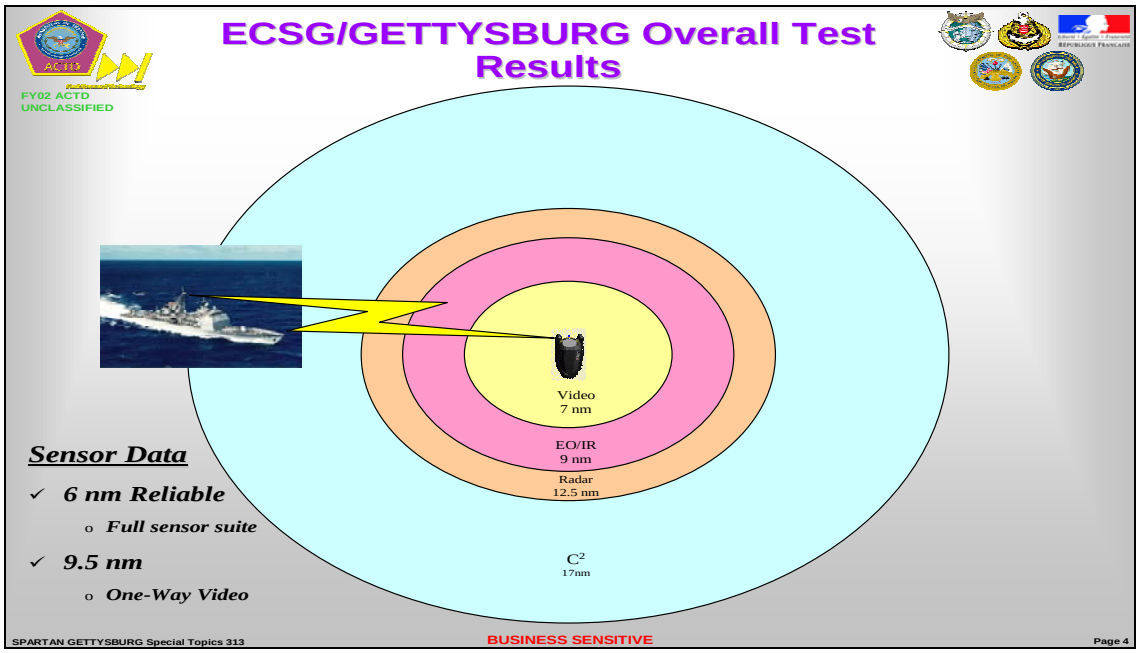

Figure 19. Spartan Scout C2/Sensor reliability ranges[35]

[35] Mark Wasilewski, Spartan Scout ACTD Gettysburg Debrief, NUWC, 26 February 2004.

There are two primary factors that affect the ability of a USV to successfully detect surface contacts. First the patrol speed of USV and second the size of the search area. Table 2 lists recommended preplanned search profiles.

Planning Factor	Influence on Deliberate USV Search Performance
USV Patrol Speed (controlled by watch team)	Increased speed yields improved detection. Patrol at 20 knots generates best outcomes, accomplished through either sprint-drift or constant speed patrol.
Average Vessel Traffic Speed (not controlled by watch team)	Higher traffic speeds increases likelihood of detection because more contacts pass through a well-situated search area. Preplanned USV search alone does not perform well if contacts are stealthy, slow, or evasive.
Search Area Size (controlled by watch team)	USV can best cover areas of 100-150-sq NM for preplanned search patrol using all available sensors on board.
Sensor Range (not controlled by watch team)	Combined sensor ranges of approximately 5 NM provide the best results. This is a function of contact size and signature (i.e., heat, or radar cross section).
Dedicated Search Time (controlled by watch team)	Dependent on the tactical scenario and platform characteristics, greater time dedicated to search yields improved probability of detection. Planned search duration of 5 hours is optimal.

Table 2. Summary of recommended USV preplanned search profiles[36]

In reference to Table 2, higher speeds and reasonable search areas yield higher contact detection probabilities. Despite the current range limitations, there is also a third factor that may limit the effectiveness of successful SSC/RMP missions. Environmental conditions also play a pivotal role in contact detection as well as ISR. For example, excess condensation on camera lenses and poor platform stability can significantly degrade the effectiveness of EOIR and PTZ camera video.

To overcome video challenges, C2/Sensor operators have to find a speed in accordance with the actual sea state that allows the USV to maintain a steady plane. As cameras zoom in on an image, the video picture becomes less coherent. In 2003, poor camera quality coupled with condensation required Spartan close within 2000-2500 yards of the COI/CCOI to read a motor vessels name, which meant the host ship had close to about 6-6.5nm of a COI/CCOI to utilize the USV's sensors. Despite the challenges, the

[36] NAVY TACMEMO, Integration of Unmanned Vehicles into Maritime Missions, TM 3-22-5-SW.

current limitations are not dramatic. Sensors and data links will continue to evolve and improve as USVs transition from experimental to dedicated fleet assets.

D. ANTI-SURFACE WARFARE (ASUW)

Currently USVs are unproven as effective ASUW platforms. As previously mentioned, USVs weapon system alternatives include the AGM-114 Hellfire missile, the Sea Javelin Missile, Gau-17A, 7.62mm Gatling Gun, or the .50 Caliber machine gun. In April 2004, "Spartan Scout ISR/FP mission modules, utilizing Compass II and ROSAM mount with M2HB .50 cal gun, were tested at the Aberdeen Proving Ground (APG)."[37] At Aberdeen, Spartan Scout recorded an overall accuracy rate of 16% on both ground and water targets. According to Robert Kosman, "the ISR/FP mission modules were able to acquire the target, maintain lock during various USV speeds (0, 7, and 15 knots), and successfully engage the target at various ranges (200-400, 800, and 1100 yards)."[38] Although this combat system is far from perfected, the results are promising. SPARTAN's live fire test results from Aberdeen are listed below.

Test Run	Hits	Shots	% Hit
Static			
200-400 yrds	17	45	38
800 yrds	10	50	20
1100 yrds	2	38	5
Crossing @ 15kts			
400 yrds	3	20	15
800 yrds	13	60	22
1100 yrds	4	42	10
Crossing @ 7kts			
400 yrds	9	74	12
Closing @ 15kts			
1100-400 yrds	4	53	8
Total	**62**	**382**	**16**

Table 3. Aberdeen Live-Fire Demonstration Results .50cal/ROSAM mount[39]

CDR William Hatch Ret. of the Naval Postgraduate School developed two ASUW intercept tactics for USVs. The first is a low-intensity intercept in which the

[37] Robert Kosman, Quick Summary of results from Aberdeen Technical Demonstration, April 2005.

[38] Robert Kosman, Quick Summary of results from Aberdeen Technical Demonstration, April 2005.

[39] Vic Ricci, Spartan Scout ACTD USV Overview and Status, NUWC, 10 March 2006.

USV crosses the bow of the COI/CCOI vessel at no less than 500 yards and maneuvers to take station off the quarter of the target vessel. The second is a high-intensity intercept in which the USV crosses the bow of the COI/CCOI vessel twice. CDR Hatch also points out that using either intercept tactic "depends on ROE, tactical environment, sea-space, and safety, mission controllers may employ assertive or nonassertive approaches by the USV."[40] Careful consideration should be taken before executing the High-Intensity Maneuver, crossing the bow of COI/CCOI twice could potentially instigate hostilities.

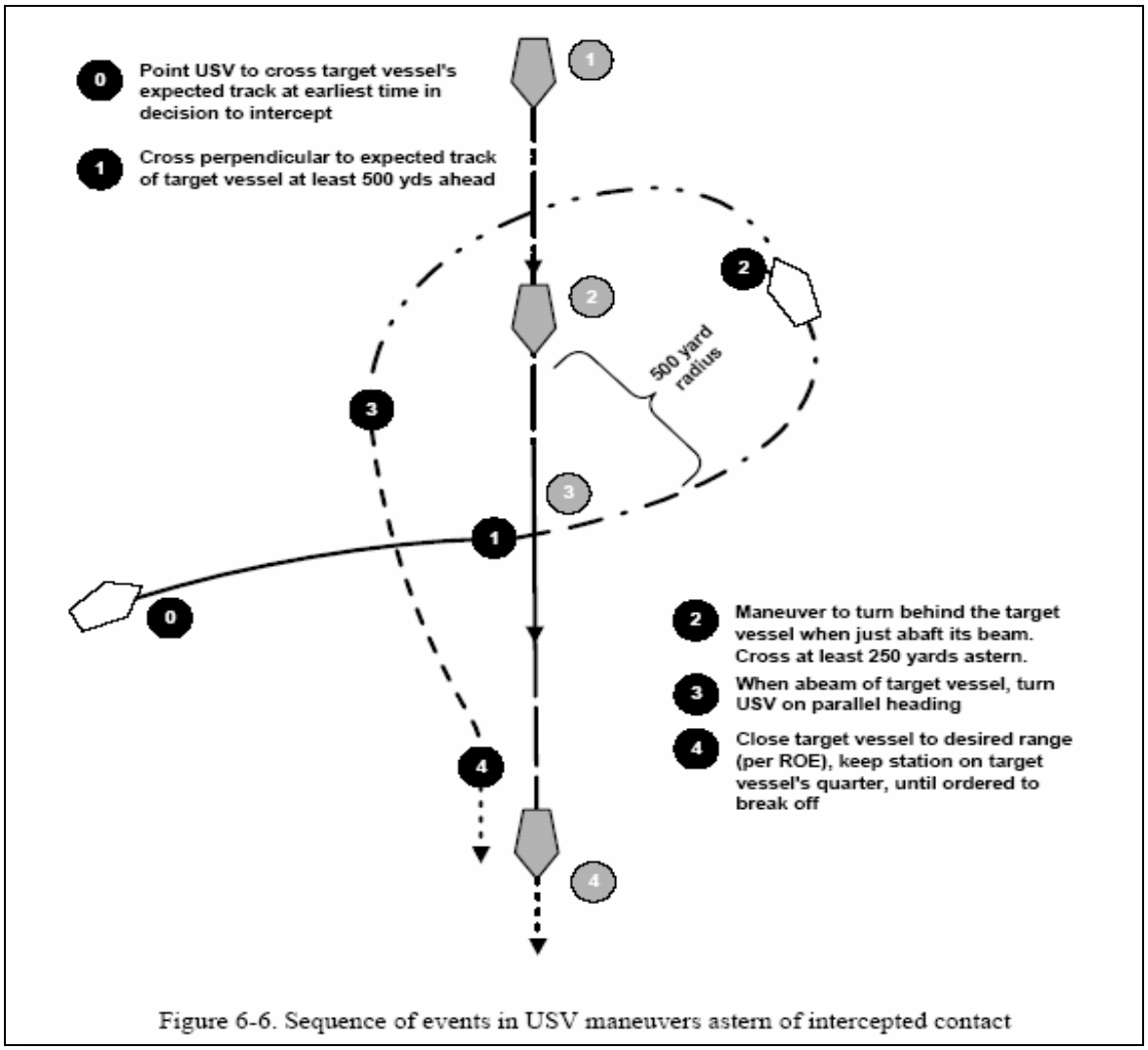

Figure 20. LOW-INTENSITY MANEUVER[41]

[40] NAVY TACMEMO, Integration of Unmanned Vehicles into Maritime Missions, TM 3-22-5-SW.

[41] NAVY TACMEMO, Integration of Unmanned Vehicles into Maritime Missions, TM 3-22-5-SW.

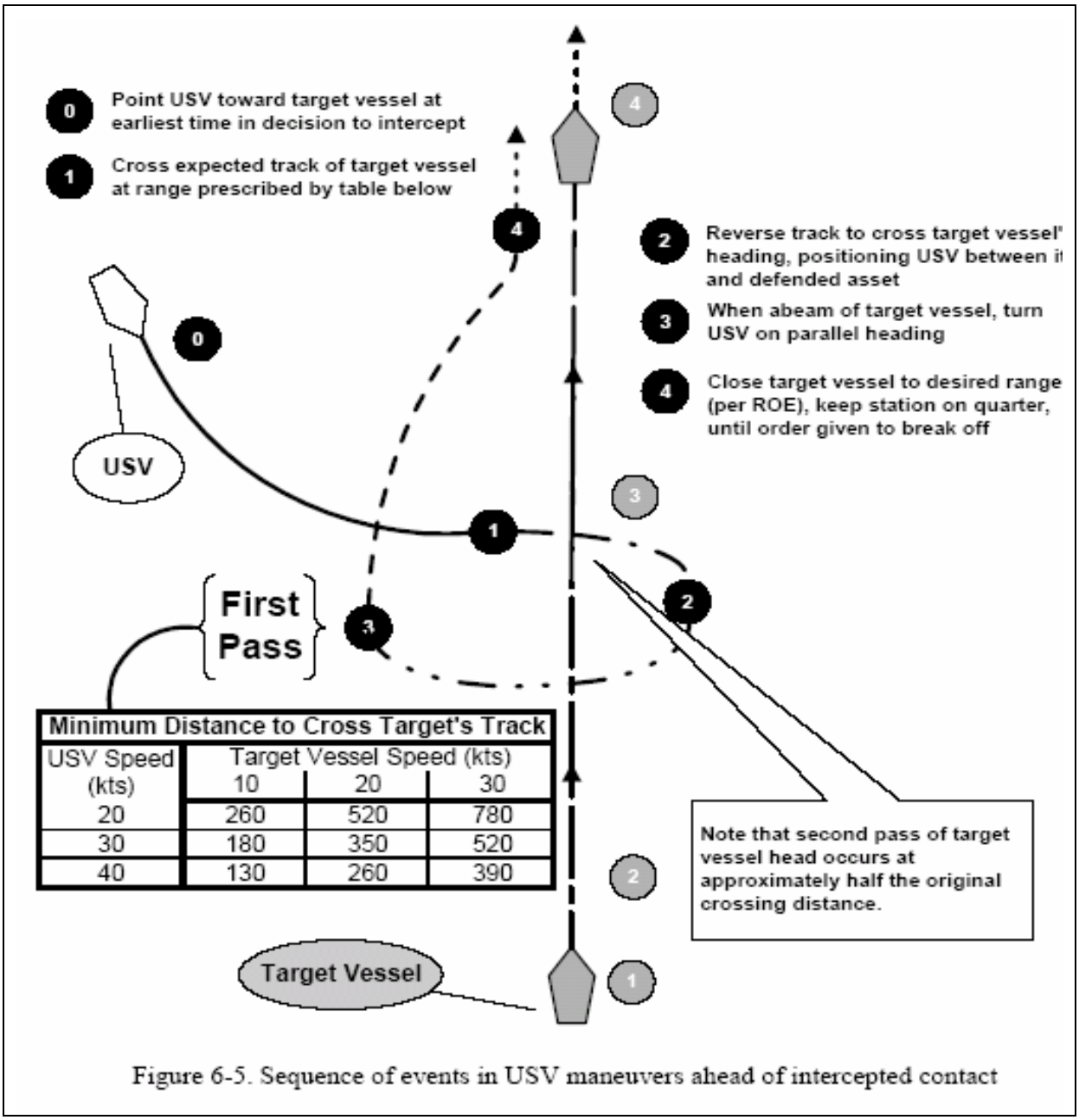

Figure 21. High-Intensity Maneuver[42]

C2 operators should pay close attention to the target vessel range and speed, as well as other shipping when attempting this maneuver.

When a COI/CCOI is threatened by a small boat or USV it may take immediate actions to counter the threat. First the contact would maneuver to open the distance

[42] NAVY TACMEMO, Integration of Unmanned Vehicles into Maritime Missions, TM 3-22-5-SW.

between itself and the USV. This action is two fold, first opening up the range reduces the immediate threat and second, it provides more time to assess the situation. If the COI/CCOI is a naval vessel and it intends to engage the USV, it will order up flank speed and maneuver in such a way to place the threat on its beam to bring as many guns to bear on its target as possible. To counter such a pre-planned response, C2 Operators should always be prepared to maneuver the USV as to maintain a position within weapons release range and off the target vessels quarter. This position provides a better target cross section than either a bow or stern only aspect and it also avoids placing the USV on the beam of a threatened surface ship.

E. MINE WARFARE (MIW)

Mine Warfare is another potential mission area for USV employment. To demonstrate military utility in the MIW, USVs had to be equipped with an effective mine-hunting sonar system. NUWC in close cooperation NSWC Panama City incorporated a Northrop Grumman AN/AQS-24 sensor onto a common towed body launch and retrieval rail system.[43]

Figure 22. 11m SPARTAN MIW USV[44]

The AN/AQS-24 is a mobile, lightweight, and real-time mine hunting sonar system that is both high-speed and high resolution. The AN/AQS-24 is essentially an

[43] Marvin, Ernest and Wasilewski, Mark. Unmanned Surface Vehicle Mission Module Development and Demonstrations, NUWC.

[44] Vic Ricci, Spartan Scout ACTD USV Overview and Status, NUWC, 10 March 2006.

updated AN/AQS-14A. Northrop Grumman added a laser to the AN/AQS-14A that "provides positive visual identification of objects and improved sonar resolution."[45] "The AN/AQS-24 uses state-of-the-art digital electronics in both the operator's console and the towfish to provide much higher resolution, longer detection ranges and deeper depth than the Q-14A."[46] Like its predecessor, the AN/AQS-24 system is so versatile it can be deployed from aircraft, surface ships, and even USVs.

Figure 23. AN/AQS-24 launch from 11m SPARTAN MIW USV[47]

Figure 24. AN/AQS-24[48]

During MIW technical testing held at Camp Pendleton in February 2006, this configuration proved successful. The Spartan Scout MIW USV successfully demonstrated remote AN/AQS-24 launch and recovery, remote AQS-24 sensor control and operator receipt of real time acoustic data, the ability to execute MIW search patterns via pre-programmed waypoints, and a deepwater tow capability at 150 feet with a cable scope of 300 feet.[49] These results may allow the AN/AQS-24 mine hunting system to become a permanent complement to the USV MIW module. In the near future, the Navy

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[45] Northrop Grumman, Marine and Naval Systems. [retrieved 15 May 2006] available from world wide web @http://www.es.northropgrumman.com/products/Oceanic_Naval_Systems_overview.htm.

[46] Northrop Grumman, Marine and Naval Systems. [retrieved 15 May 2006] available from world wide web @http://www.es.northropgrumman.com/products/Oceanic_Naval_Systems_overview.htm.

[47] Vic Ricci, Spartan Scout ACTD USV Overview and Status, NUWC, 10 March 2001.

[48] Northrop Grumman, Marine and Naval Systems. [retrieved 15 May 2006] available from world wide web @http://www.es.northropgrumman.com/products/Oceanic_Naval_Systems_overview.htm

[49] Vic Ricci, Spartan Scout ACTD USV Overview and Status, NUWC, 10 March 2001.

may have one more weapon in its MIW arsenal. USV's working in tandem with SH-60F Helicopters and UUVs could dominate future MIW operations.

A USV may become a force multiplier in MIW when equipped with the AN/AQS -24 mine hunting system. In addition to mine detection, localization and classification of both bottom and moored mines, the SPARTAN MIW could provide a host ship with real time quality imagery of the littorals. Like the AN/WLD -1(V)1 Remote Mine hunting System (RMS), a Spartan MIW USV equipped with an AN/AQS-24 could be launched from surface ship and sent on a pre-programmed way-point route to conduct mine hunting operations in a suspect body of water.

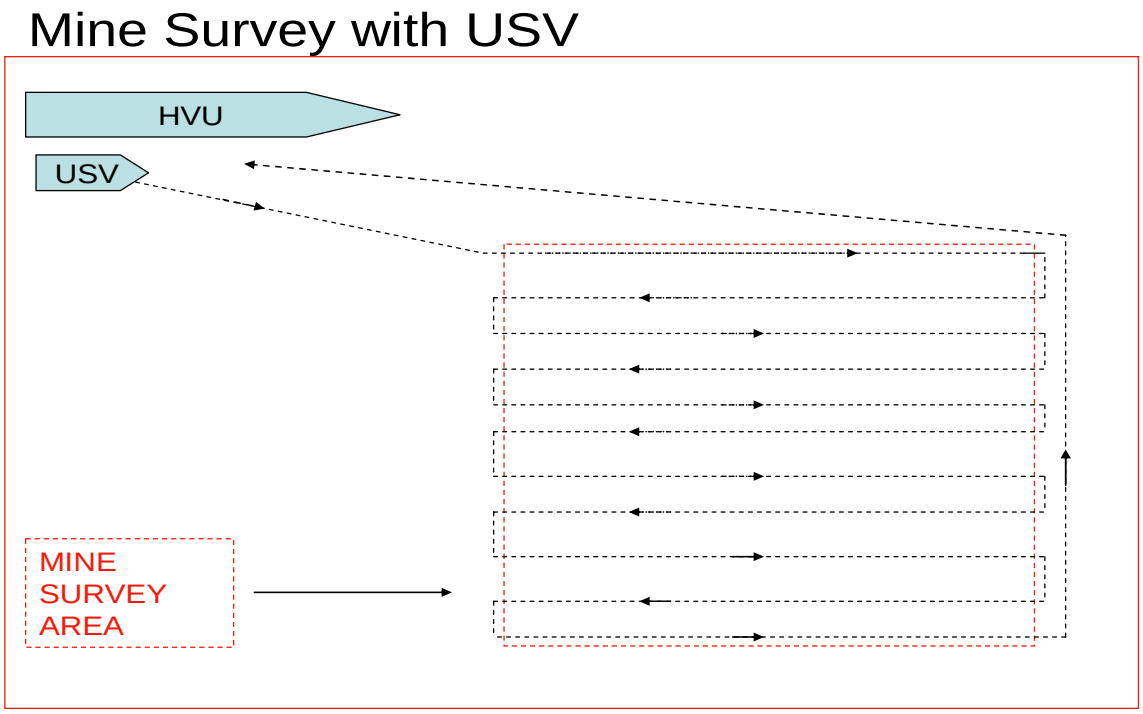

Figure 25. Notional Mine hunting Survey using MIW USV

The survey method illustrated in figure 25 is designed to search a suspect body of water for mines. The number of passes through the mine survey area depends upon the effective range of the sonar and the size of the search area. C2 operators should dissect the search area in such a way that the sonar coverage area overlaps the previous pass.

This may help to reduce the chances of a mine from going undetected. When conducting a survey, C2 operators must always be aware of set and drift, shipping, and navigational hazards.

F. CHOKE POINT/STRAIT TRANSIT

Choke point or strait transits represent significant vulnerability for a HVU and its escorts. Limited water space, high traffic, and the littorals offer minimal maneuverability and a wide range of possible threats. To counter the myriad of threats, an ESG or CSG will launch USV's and organic air assets, form a column at standard distance, and order PIM speed prior to commencing the strait transit. During the transit, the water space around the HVU will be divided into four quadrants. At least one organic air asset will be stationed to both the port and starboard side of the HVU to provide force protection. USV's will be utilized to provide a screen for blue water vessels during strait transits. In addition, at least one small boat or USV will be dedicated to each quadrant.

Escort combatants lead the column as all ships maintain a tight formation. This maneuver is designed discourage shipping from crossing between as the formation steams through the straits. The range of the force protection perimeter and the number of USV's to be employed would be assigned by the CSG/ESG Commander. In each defense quadrant, the USV's primary mission is to deter, prevent, and if necessary intercept local shipping that attempt crossing through or dividing the column while transiting. The figure 26 illustrates a notional strait transit tactic utilizing USVs.

All USVs will maintain transit PIM speed in accordance with CSG or ESG Operational Orders. USVs in each defense quadrant should maintain a minimum standard distance of 100 yards from the HVU. However, the standard distance can be expanded or contracted at the discretion of the CSG/ESG Commander depending upon traffic density, navigational hazards, and traffic separation scheme considerations. The USV assigned to quadrant 1 is responsible for screening the HVU from the threats bearing 260 to 015 degrees relative from the HVU. The USV assigned to quadrant 2 is responsible for screening the HVU from threats bearing 345-115 degrees relative from the HVU. The USV assigned to quadrant 3 will screen the HVU from threats bearing 165-285 degrees relative from the HVU. The USV assigned to quadrant 4 will screen the HVU from threats bearing 075-195 degrees relative from the HVU.

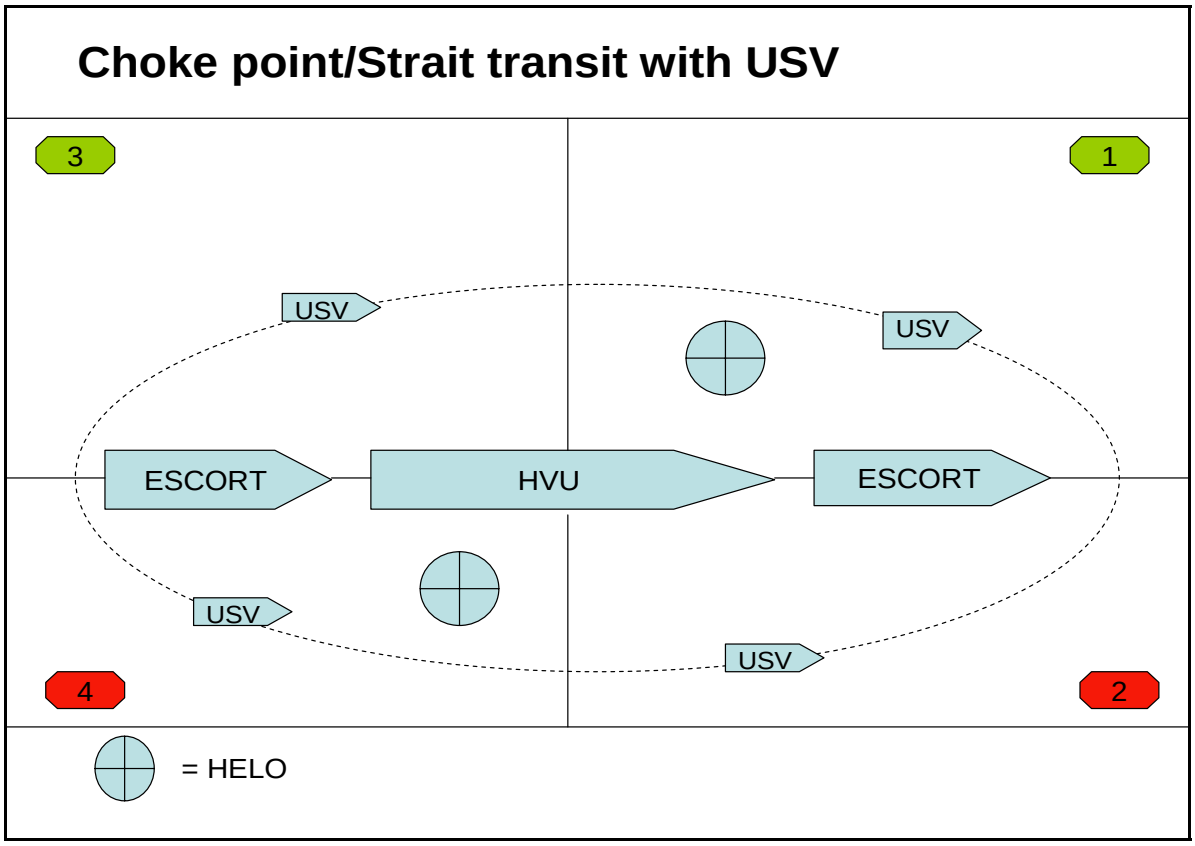

Figure 26. Choke Point/Strait Transit with USV

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VI. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

A. SUMMARY

This research analyzed primary and secondary surface warfare mission elements that USV operation support, the manpower implications associated with projected USV weapons modules, the manpower qualities required for general USV Launch and Recovery (L & R), and the existing and proposed operational tactics for various USV missions. The research methodology included reviews of lessons learned, Advanced Concept Technology Demonstrations Final Reports, Military Utility Assessments, and USV test data. Additionally, Navy Occupational Standards and Classifications, Manpower and Manning Documents, USV tactical memorandums, various capability and limitations of Naval weapon systems, NPS Theses, and USV Quicklook summaries were analyzed.

This research found that additional warfighting capabilities can be gained by equipping surface warfare vessels with USVs. The replacement of the Navy standard RHIB with a USV will enhance a ship's layered defense architecture and provide the resource sponsor a best-value platform with both offensive and defensive capabilities. This addition would cause no negative effects to existing primary or secondary warfare missions. It was found that USVs actually enhanced current design capabilities of Naval warfighting vessels. Although the potential of USV operations is vast, the actual operational effectiveness of USVs remains to be proven. Overall, environmental conditions and antenna placement are critical limiting factors in USV operations. Environmental conditions such as high sea state and heavy rain reduce the C2/sensor operator's visibility through USV cameras and significantly reduce the effectiveness of USV operations. Two issues are problematic for the USV data link antenna placement (900mhz, UHF, or VHF). First, the height of the antenna has a direct impact on the effective range of the data link. Second, antenna placement may result in host ship signal cutouts.

As a result, USV operations directly support a capabilities based Navy. Despite the current design limitations, future USV operations directly support a capabilities based Navy.

B. CONCLUSION AND RECOMMENDATIONS

1. Primary Research Questions

a. What Primary or Secondary Surface Warfare Mission Elements Do USV Operations Support?

Conclusion: USV operations support primary mission elements such as ASW and ASUW. In addition, USV Operations will enhance the host ship's point defense (PD) and provide limited AAW capability. USV's with Javelin or Hellfire modules will be limited to engaging only helicopters and low-slow flying aircraft. The USV's 5nm range restriction from host ship is due to a limited RF communications and data link. This is the primary factor that limits a USV's capability in supporting the host ship's primary mission elements.

USV operations also support secondary mission elements such as AT/FP, MIO, MIW, and SSC/RMP. The USV's ability to execute pre-programmed routes via GPS waypoints make it an exceptional platform for MIW surveying and FP harbor patrols. In addition, the EO/IR, PTZ, AN/AQS-24 sonar, and radar make the USV capable platform in supporting MIO and SSC/RMP. However, the USV's capability in each of these secondary mission areas is limited to 5nm from host ship.

Recommendation:

- Develop a high-quality extended range (HQER) RF Data link to overcome the 5nm range limitation of USV Operations. This will significantly improve the capability of USV's and revolutionize fleet operations. In addition, it will enhance the current layered defense architecture at sea.

b. What are the Manpower Implications as They Relate to Weapon Systems, Maintenance, Loading/Unloading and Delivery?

Conclusion: The four primary USV weapons modules being tested are the .50 Caliber Machine Gun, the GAU-17A, 7.62mm Gatling Gun, the Javelin Missile, and the Hellfire Missile (AGM-114A). No significant manpower hurdles are expected for the .50 Caliber or the GAU-17A because both are fleet crew served weapons.

The addition of the Hellfire (AGM-114A) weapons module does not appear to create any significant manpower implications. Current occupational standards for GM and AO sufficiently cover handling requirements for Hellfire. In addition, both GM's and AO's have fleet experience in handling the Hellfire. This determination depends mostly on how the Navy will ultimately organize USV assets. Specifically, will the Navy establish USV Squadrons, or if USVs will replace standard RHIBS on Naval vessels. AO's have the formal NEC AO-6801 Air Launched Weapons Technician to support Hellfire. In contrast, GM Missile Maintenance Technicians GM 0891-0991 would only need to receive Hellfire specific training to close the gap.

However, the Javelin System is different. The Navy has not established a Javelin NEC because it is a USA/USMC weapon system. The Navy has three basic options; one, send GM's to USA/USMC Javelin Training. Second, incorporate Army MOS 45K Javelin System into an existing family of NECs such as GM Missile Maintenance Technician (GM 0981-0991). Third, the Navy could create a new NEC.

All USV weapons modules will be mounted to the new MK49 Mod 0 (ROSAM) fire control system. Navy FC's have a solid background in supporting Optical Sight Systems. The Navy has already established NEC FC-1139 to maintain MK46 Mod 1 OSS on Aegis Destroyers. The MK49 MOD 0 OSS/FCS could be added to NEC FC-1139 or the Navy could create an exclusive NEC for the MK49 MOD 0 OSS.

Recommendations:

- The Navy must determine how USVs will be organized for fleet service. If USV squadrons are established AO's and GM's are both potential source ratings for a Hellfire NEC.
- Create Javelin specific NEC for GM Missile Maintenance Technicians
- Add GM to source rating code for Hellfire Missile
- Create ROSAM specific NEC for FC MK49 Mod 0 OSS (ROSAM) FCS Technician
- Create standardized USV weapons modules

c. What are the Manpower Qualities Required for a General Launch and Recovery of a USV?

Conclusion: Only USV centric manpower qualities additional to those required to successfully launch and recover a standard RHIB are discussed. USV SOP's

and L & R methods cannot be established until a standardized USV platform enters fleet service. Therefore, Chapter IV lists the minimum manpower qualities required for USV C2 Pilots, Sensor Operators, Pre-Launch checks, and weapons module support.

The manpower requirement for C2 pilot and sensor operator can be filled by either Officers or enlisted.

Recommendations:

- Create NEC for USV electrical/electronic support technician
- Add ET as source rating for USV electrical/electronic support NEC
- Add FC as source rating for USV electrical/electronic support NEC
- Add FT as source rating for USV electrical/electronic support NEC

2. Secondary Research Question

a. What Operational Tactics Exist and Still Remain to be Developed for USVs?

Conclusion: This research describes notional USV operational tactics to be used in MIO, MIW, SSC/RMP, AT/FP, ASUW, and Choke Point/Strait Transit with HVU. The USV MIO Horseshoe tactic will provide surveillance on the disengaged side of a suspect vessel and significantly enhance the safety and security of VBSS teams. The MIW survey tactic allows USV C2 pilots/sensor operators to patrol a suspect body of water for mines via pre-programmed GPS waypoints. This tactic coupled with host ship organic sensors will increase the probability of successful mine detection. Two provocative USV ASUW intercept tactics were devised at the Naval Postgraduate School. However, a Commander utilizing either the low-intensity intercept or the high-intensity intercept must have a firm understanding of ROE due to their provocative nature. USV ATFP maneuvers include pre-programmed harbor patrol and small craft intercept. All of the notional USV tactics described in this research are exclusively designed for short range USV operations due to C2 data link limitations. For this reason alone, primary and secondary USV missions such as ASUW, AAW, and SSC/RMP lack tactical, operational, and strategic significance.

Recommendation:

- Further develop UV TACMEMO
- Increase the operational range of USV from host ship
- Develop long range USV operational tactics for ASUW, SSC, and RMP
- Develop USV Riverine tactics

C. RECOMMENDED FUTURE RESEARCH

Conduct a cost benefit analysis of standing up USV Squadrons versus standard RHIB and USV on Naval combatants. Conduct research to determine both the operational and maintenance hours required to support USV operations for proposed fleet units. Conduct research on USMC UV assets assigned to Navy units.

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APPENDIX A. OCCUPATIONAL STANDARDS ELECTRONICS TECHNICIAN THIRD CLASS (ET3)

ELECTRONICS TECHNICIAN (SURFACE) THIRD CLASS (ET3)

A. RADAR SYSTEMS
A001 TROUBLESHOOT RADAR EQUIPMENT
A002 ADJUST AND ALIGN RADAR EQUIPMENT
A003 REPLACE COMPONENTS ON RADAR EQUIPMENT
A004 TEST AND OPERATE RADAR EQUIPMENT
A005 EVALUATE PERFORMANCE OF RADAR EQUIPMENT
A006 CLEAN AND INSPECT RADAR EQUIPMENT
A007 REPLACE MODULES AND CIRCUIT CARDS ON RADAR EQUIPMENT
A008 TROUBLESHOOT RADAR ANTENNA SYSTEMS
A009 ADJUST AND ALIGN RADAR ANTENNA SYSTEMS
A010 REPLACE COMPONENTS ON RADAR ANTENNA SYSTEMS
A011 TEST AND OPERATE RADAR ANTENNA SYSTEMS
A012 EVALUATE PERFORMANCE OF RADAR ANTENNA SYSTEMS
A013 CLEAN AND INSPECT RADAR ANTENNA SYSTEMS
A014 REPLACE MODULES AND CIRCUIT CARDS ON RADAR ANTENNA SYSTEMS
A015 BORESIGHT RADAR ANTENNA
A016 TROUBLESHOOT IDENTIFICATION FRIEND OR FOE (IFF) EQUIPMENT
A017 TEST AND OPERATE IFF EQUIPMENT
A018 EVALUATE PERFORMANCE OF IFF EQUIPMENT
A019 REPLACE MODULES AND CIRCUIT CARDS ON IFF EQUIPMENT
A020 TROUBLESHOOT REPEATER AND INDICATORS
A021 ADJUST AND ALIGN REPEATER AND INDICATORS
A022 REPLACE COMPONENTS ON REPEATER AND INDICATORS
A023 TEST AND OPERATE REPEATER AND INDICATORS
A024 EVALUATE PERFORMANCE OF REPEATER AND INDICATORS
A025 CLEAN AND INSPECT REPEATER AND INDICATORS
A026 REPLACE MODULES AND CIRCUIT CARDS ON REPEATER AND INDICATORS
B. NAVIGATION SYSTEMS
B027 TEST AND OPERATE GLOBAL POSITIONING SYSTEM (GPS) EQUIPMENT
B028 EVALUATE PERFORMANCE OF GPS EQUIPMENT
B029 TROUBLESHOOT TACTICAL AIR NAVIGATION (TACAN) EQUIPMENT
B030 REPLACE COMPONENTS ON TACAN EQUIPMENT
B031 TEST AND OPERATE TACAN EQUIPMENT
B032 EVALUATE PERFORMANCE OF TACAN EQUIPMENT
B033 REPLACE MODULES AND CIRCUIT CARDS ON TACAN EQUIPMENT
B034 TROUBLESHOOT FATHOMETERS
B035 TEST AND OPERATE SATELLITE NAVIGATION (SATNAV) EQUIPMENT
B036 EVALUATE PERFORMANCE OF SATNAV EQUIPMENT
B037 CLEAN AND INSPECT SATNAV EQUIPMENT
C. COMMUNICATION SYSTEMS
C038 TROUBLESHOOT HIGH FREQUENCY (HF) RECEIVERS
C039 ADJUST AND ALIGN HF RECEIVERS
C040 REPLACE COMPONENTS ON HF RECEIVERS
C041 TEST AND OPERATE HF RECEIVERS
C042 EVALUATE PERFORMANCE OF HF RECEIVERS
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C043 CLEAN AND INSPECT HF RECEIVERS
C044 REPLACE MODULES AND CIRCUIT CARDS ON HF RECEIVERS
C045 TROUBLESHOOT HF TRANSMITTERS
C046 ADJUST AND ALIGN HF TRANSMITTERS
C047 REPLACE COMPONENTS ON HF TRANSMITTERS
C048 TEST AND OPERATE HF TRANSMITTERS
C049 EVALUATE PERFORMANCE OF HF TRANSMITTERS
C050 CLEAN AND INSPECT HF TRANSMITTERS
C051 REPLACE MODULES AND CIRCUIT CARDS ON HF TRANSMITTERS
C052 TROUBLESHOOT VERY HIGH FREQUENCY/ULTRA HIGH FREQUENCY (VHF/UHF) RECEIVERS
C053 ADJUST AND ALIGN VHF/UHF RECEIVERS
C054 REPLACE COMPONENTS ON VHF/UHF RECEIVERS
C055 TEST AND OPERATE VHF/UHF RECEIVERS
C056 EVALUATE PERFORMANCE OF VHF/UHF RECEIVERS
C057 CLEAN AND INSPECT VHF/UHF RECEIVERS

C058 REPLACE MODULES AND CIRCUIT CARDS ON VHF/UHF RECEIVERS
C059 TROUBLESHOOT VHF/UHF TRANSMITTERS
C060 ADJUST AND ALIGN VHF/UHF TRANSMITTERS
C061 REPLACE COMPONENTS ON VHF/UHF TRANSMITTERS
C062 TEST AND OPERATE VHF/UHF TRANSMITTERS
C063 EVALUATE PERFORMANCE OF VHF/UHF TRANSMITTERS
C064 CLEAN AND INSPECT VHF/UHF TRANSMITTERS
C065 REPLACE MODULES AND CIRCUIT CARDS ON VHF/UHF TRANSMITTERS
C066 TROUBLESHOOT VHF/UHF TRANSCEIVERS
C067 ADJUST AND ALIGN VHF/UHF TRANSCEIVERS
C068 REPLACE COMPONENTS ON VHF/UHF TRANSCEIVERS
C069 TEST AND OPERATE VHF/UHF TRANSCEIVERS
C070 EVALUATE PERFORMANCE OF VHF/UHF TRANSCEIVERS
C071 CLEAN AND INSPECT VHF/UHF TRANSCEIVERS
C072 REPLACE MODULES AND CIRCUIT CARDS ON VHF/UHF TRANSCEIVERS
C073 TROUBLESHOOT SINGLE AUDIO SYSTEMS (SAS) EQUIPMENT
C074 ADJUST AND ALIGN SAS EQUIPMENT
C075 TEST AND OPERATE SAS EQUIPMENT
C076 EVALUATE PERFORMANCE OF SAS EQUIPMENT
C077 CLEAN AND INSPECT SAS UNITS
C078 PERFORM FUNCTIONAL CHECKS ON SECURE VOICE SYSTEMS (SVS)
C079 TROUBLESHOOT COUPLERS
C080 ADJUST AND ALIGN COUPLERS
C081 REPLACE COMPONENTS OF COUPLERS
C082 TEST AND OPERATE COUPLERS
C083 EVALUATE PERFORMANCE OF COUPLERS
C084 CLEAN AND INSPECT COUPLERS
C085 REPLACE MODULES AND CIRCUIT CARDS ON COUPLERS
C086 TROUBLESHOOT MULTICOUPLERS
C087 ADJUST AND ALIGN MULTICOUPLERS
C088 REPLACE COMPONENTS ON MULTICOUPLERS
C089 TEST AND OPERATE MULTICOUPLERS
C090 EVALUATE PERFORMANCE OF MULTICOUPLERS
C091 CLEAN AND INSPECT MULTICOUPLERS
C092 REPLACE MODULES AND CIRCUIT CARDS ON MULTICOUPLERS
C093 TROUBLESHOOT ANTENNA CONTROL SYSTEM EQUIPMENT
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C094 ADJUST AND ALIGN ANTENNA CONTROL SYSTEM EQUIPMENT
C095 REPLACE COMPONENTS ON ANTENNA CONTROL SYSTEM EQUIPMENT
C096 TEST AND OPERATE ANTENNA CONTROL SYSTEM EQUIPMENT
C097 EVALUATE PERFORMANCE OF ANTENNA CONTROL SYSTEM EQUIPMENT
C098 CLEAN AND INSPECT ANTENNA CONTROL SYSTEM EQUIPMENT
C099 REPLACE MODULES AND CIRCUIT CARDS ON ANTENNA CONTROL SYSTEM EQUIPMENT
C100 TEST AND OPERATE WHIP ANTENNAS
C101 EVALUATE PERFORMANCE OF WHIP ANTENNAS
C102 CLEAN AND INSPECT WHIP ANTENNAS
C103 TROUBLESHOOT UHF ANTENNAS
C104 TEST AND OPERATE UHF ANTENNAS
C105 EVALUATE PERFORMANCE OF UHF ANTENNAS
C106 CLEAN AND INSPECT UHF ANTENNAS
C107 REMOVE AND REPLACE ANTENNAS
C108 TROUBLESHOOT ANTENNA FILTERS
C109 ADJUST AND ALIGN ANTENNA FILTERS
C110 REPLACE COMPONENTS ON ANTENNA FILTERS
C111 TEST AND OPERATE ANTENNA FILTERS
C112 EVALUATE PERFORMANCE OF ANTENNA FILTERS
C113 CLEAN AND INSPECT ANTENNA FILTERS
C114 PERFORM FUNCTIONAL CHECKS ON ELECTRONIC FREQUENCY CONVERTERS
C115 TROUBLESHOOT CONVERTERS
C116 MONITOR UNINTERRUPTIBLE POWER SUPPLIES (UPS) (CURRENT, VOLTAGE, AND FREQUENCY)
C117 PERFORM FUNCTIONAL CHECKS ON UPS
C118 ADJUST AND ALIGN CONVERTERS
C119 REPLACE COMPONENTS ON CONVERTERS
C120 TEST AND OPERATE CONVERTERS
C121 EVALUATE PERFORMANCE OF CONVERTERS
C122 CLEAN AND INSPECT CONVERTERS
C123 REPLACE MODULES AND CIRCUIT CARDS ON CONVERTERS
C124 TROUBLESHOOT KEYER AND ADAPTER EQUIPMENT

C125 ADJUST AND ALIGN KEYER AND ADAPTER EQUIPMENT
C126 REPLACE COMPONENTS ON KEYER AND ADAPTER EQUIPMENT
C127 TEST AND OPERATE KEYER AND ADAPTER EQUIPMENT
C128 EVALUATE PERFORMANCE OF KEYER AND ADAPTER EQUIPMENT
C129 CLEAN AND INSPECT KEYER AND ADAPTER EQUIPMENT
C130 REPLACE MODULES AND CIRCUIT CARDS ON KEYER AND ADAPTER EQUIPMENT
C131 PERFORM FUNCTIONAL CHECKS ON DATA LINK TERMINAL SETS
C132 CLEAN AND INSPECT DATA LINK TERMINAL SETS
C133 TROUBLESHOOT DATA LINK TERMINAL SETS
C134 TROUBLESHOOT MULTIPLEXERS
C135 ADJUST AND ALIGN MULTIPLEXERS
C136 REPLACE COMPONENTS ON MULTIPLEXERS
C137 TEST AND OPERATE MULTIPLEXERS
C138 EVALUATE PERFORMANCE OF MULTIPLEXERS
C139 CLEAN AND INSPECT MULTIPLEXERS
C140 REPLACE MODULES AND CIRCUIT CARDS ON MULTIPLEXERS
C141 TROUBLESHOOT PORTABLE RADIOS
C142 ADJUST AND ALIGN PORTABLE RADIOS
C143 REPLACE COMPONENTS ON PORTABLE RADIOS
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C144 TEST AND OPERATE PORTABLE RADIOS
C145 EVALUATE PERFORMANCE OF PORTABLE RADIOS
C146 CLEAN AND INSPECT PORTABLE RADIOS
C147 REPLACE MODULES AND CIRCUIT CARDS ON PORTABLE RADIOS
C148 TROUBLESHOOT AUDIO AMPLIFIERS
C149 ADJUST AND ALIGN AUDIO AMPLIFIERS
C150 REPLACE COMPONENTS ON AUDIO AMPLIFIERS
C151 TEST AND OPERATE AUDIO AMPLIFIERS
C152 EVALUATE PERFORMANCE OF AUDIO AMPLIFIERS
C153 CLEAN AND INSPECT AUDIO AMPLIFIERS
C154 REPLACE MODULES AND CIRCUIT CARDS ON AUDIO AMPLIFIERS
E. AUXILIARY/SUPPORT EQUIPMENT
E155 TROUBLESHOOT LOW LEVEL PATCH PANELS
E156 ADJUST AND ALIGN LOW LEVEL PATCH PANELS
E157 REPLACE COMPONENTS ON LOW LEVEL PATCH PANELS
E158 TEST AND OPERATE LOW LEVEL PATCH PANELS
E159 EVALUATE PERFORMANCE OF LOW LEVEL PATCH PANELS
E160 CLEAN AND INSPECT LOW LEVEL PATCH PANELS
E161 REPLACE MODULES AND CIRCUIT CARDS ON LOW LEVEL PATCH PANELS
E162 TROUBLESHOOT RADIO FREQUENCY (RF) PATCH PANELS
E163 TEST AND OPERATE RF PATCH PANELS
E164 TROUBLESHOOT AUDIO PATCH PANELS
E165 ADJUST AND ALIGN AUDIO PATCH PANELS
E166 REPLACE COMPONENTS ON AUDIO PATCH PANELS
E167 TEST AND OPERATE AUDIO PATCH PANELS
E168 EVALUATE PERFORMANCE OF AUDIO PATCH PANELS
E169 CLEAN AND INSPECT AUDIO PATCH PANELS
E170 REPLACE MODULES AND CIRCUIT CARDS ON AUDIO PATCH PANELS
E171 MONITOR DRY AIR CONTROL PANELS
E172 TEST AND OPERATE DRY AIR SYSTEMS
E173 EVALUATE PERFORMANCE OF DRY AIR SYSTEMS
E174 CLEAN AND INSPECT DRY AIR SYSTEMS
E175 PURGE DRY AIR SYSTEMS
E176 TROUBLESHOOT SYNCHROS AND SERVO SYSTEMS
E177 ADJUST AND ALIGN SYNCHROS AND SERVO SYSTEMS
E178 REPLACE COMPONENTS ON SYNCHROS AND SERVO SYSTEMS
E179 TEST AND OPERATE SYNCHROS AND SERVO SYSTEMS
E180 EVALUATE PERFORMANCE OF SYNCHROS AND SERVO SYSTEMS
E181 CLEAN AND INSPECT SYNCHROS AND SERVO SYSTEMS
E182 ADJUST AND ALIGN RESOLVERS
E183 TROUBLESHOOT RADAR SWITCHBOARDS
E184 REPLACE COMPONENTS ON RADAR SWITCHBOARDS
E185 TEST AND OPERATE RADAR SWITCHBOARDS
E186 EVALUATE PERFORMANCE OF RADAR SWITCHBOARDS
E187 CLEAN AND INSPECT RADAR SWITCHBOARDS
E188 REPLACE MODULES AND CIRCUIT CARDS ON RADAR SWITCHBOARDS
E189 TROUBLESHOOT TRIGGER AND PULSE AMPLIFIERS
E190 ADJUST AND ALIGN TRIGGER AND PULSE AMPLIFIERS
E191 REPLACE COMPONENTS ON TRIGGER AND PULSE AMPLIFIERS
E192 TEST AND OPERATE TRIGGER AND PULSE AMPLIFIERS

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E193 EVALUATE PERFORMANCE OF TRIGGER AND PULSE AMPLIFIERS
E194 CLEAN AND INSPECT TRIGGER AND PULSE AMPLIFIERS
E195 REPLACE MODULES AND CIRCUIT CARDS ON TRIGGER AND PULSE AMPLIFIERS
E196 TROUBLESHOOT FACSIMILE (FAX) EQUIPMENT
E197 ADJUST AND ALIGN FAX EQUIPMENT
E198 REPLACE COMPONENTS ON FAX EQUIPMENT
E199 TEST AND OPERATE FAX EQUIPMENT
E200 EVALUATE PERFORMANCE OF FAX EQUIPMENT
E201 CLEAN AND INSPECT FAX EQUIPMENT
E202 REPLACE MODULES AND CIRCUIT CARDS ON FAX EQUIPMENT
E203 TROUBLESHOOT VIDEO AMPLIFIERS
E204 ADJUST AND ALIGN VIDEO AMPLIFIERS
E205 REPLACE COMPONENTS ON VIDEO AMPLIFIERS
E206 TEST AND OPERATE VIDEO AMPLIFIERS
E207 EVALUATE PERFORMANCE OF VIDEO AMPLIFIERS
E208 CLEAN AND INSPECT VIDEO AMPLIFIERS
E209 REPLACE MODULES AND CIRCUIT CARDS ON VIDEO AMPLIFIERS
E210 PERFORM FUNCTIONAL CHECKS ON VIDEO MONITORS
E211 CLEAN AND INSPECT VIDEO MONITORS
E212 ADJUST AND ALIGN VIDEO MONITORS
E213 TROUBLESHOOT VIDEO MONITORS
E214 REMOVE AND REPLACE VIDEO MONITOR COMPONENTS
E215 PERFORM FUNCTIONAL CHECKS ON VIDEO TERMINALS
E216 CLEAN AND INSPECT VIDEO TERMINALS
E217 ADJUST AND ALIGN VIDEO TERMINALS
E218 TROUBLESHOOT VIDEO TERMINALS
E219 REMOVE AND REPLACE VIDEO TERMINAL COMPONENTS
E220 TROUBLESHOOT COPIER EQUIPMENT
E221 ADJUST AND ALIGN COPIER EQUIPMENT
E222 TEST AND OPERATE COPIER EQUIPMENT
E223 TEST AND OPERATE ELECTRONIC EQUIPMENT COOLING SYSTEMS
E224 EVALUATE PERFORMANCE OF ELECTRONIC EQUIPMENT COOLING SYSTEMS
E225 CLEAN AND INSPECT ELECTRONIC EQUIPMENT COOLING SYSTEMS
E226 PERFORM FUNCTIONAL CHECKS ON LOW PRESSURE (LP) AIR COMPRESSORS
E227 CLEAN AND INSPECT LP AIR COMPRESSORS
F. COMPUTER/AUTOMATED INFORMATION SYSTEM (AIS) EQUIPMENT
F228 LOAD DIAGNOSTIC PROGRAMS
F229 MONITOR DIAGNOSTIC PROGRAMS
F230 RECORD RESULTS OF DIAGNOSTIC PROGRAMS
F231 ANALYZE RESULTS OF DIAGNOSTIC MAINTENANCE
F232 REMOVE AND REPLACE MAINFRAME COMPUTER
F233 PERFORM FUNCTIONAL CHECKS ON MINICOMPUTERS (AN/UYK-7, AN/UYK-20, AN/UYK-43, AN/UYK-62, SNAP II, ETC.)
F234 CLEAN AND INSPECT MINICOMPUTERS
F235 TROUBLESHOOT MINICOMPUTERS
F236 REMOVE AND REPLACE MINICOMPUTER ASSEMBLIES
F237 PERFORM FUNCTIONAL CHECKS ON HARD DISK MEMORY UNITS
F238 CLEAN AND INSPECT HARD DISK MEMORY UNITS
F239 TROUBLESHOOT HARD DISK MEMORY UNITS
F240 PERFORM FUNCTIONAL CHECKS ON HARD DISK MEMORY CONTROLLERS (DMC)
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F241 CLEAN AND INSPECT HARD DMC
F242 TROUBLESHOOT HARD DMC
F243 REMOVE AND REPLACE HARD DMC COMPONENTS
F244 PERFORM FUNCTIONAL CHECKS ON COMPACT DISK READ ONLY MEMORY (CD ROM)
F245 CLEAN AND INSPECT CD ROM UNITS
F246 TROUBLESHOOT CD ROM UNITS
F247 PERFORM FUNCTIONAL CHECKS ON FLEXIBLE DISKETTE (FLOPPY) DRIVE UNITS
F248 CLEAN AND INSPECT FLOPPY DRIVE UNITS
F249 REMOVE AND REPLACE FLOPPY DRIVE UNITS
F250 PERFORM FUNCTIONAL CHECKS ON MAGNETIC TAPE UNITS (MTU)
F251 CLEAN AND INSPECT MTU
F252 LUBRICATE MTU
F253 TROUBLESHOOT MTU
F254 REMOVE AND REPLACE MTU COMPONENTS
F255 ADJUST AND ALIGN MAGNETIC TAPE CONTROLLERS
F256 TROUBLESHOOT MAGNETIC TAPE CONTROLLERS
F257 PERFORM FUNCTIONAL CHECKS ON MAGNETIC TAPE CERTIFIER/CLEANERS
F258 PERFORM FUNCTIONAL CHECKS ON PAPER TAPE PUNCH/READER UNITS

F259 CLEAN AND INSPECT PAPER TAPE PUNCH/READER UNITS
F260 LUBRICATE PAPER TAPE PUNCH/READER UNITS
F261 TROUBLESHOOT PAPER TAPE PUNCH/READER UNITS
F262 REMOVE AND REPLACE PAPER TAPE PUNCH/READER UNIT COMPONENTS
F263 ADJUST AND ALIGN PAPER TAPE PUNCH/READER UNITS
F264 CLEAN AND INSPECT COMPUTER KEYBOARDS
F265 PERFORM FUNCTIONAL CHECKS ON IMPACT PRINTERS/PLOTTERS (DOT MATRIX, DAISY WHEEL, ETC.)
F266 CLEAN AND INSPECT IMPACT PRINTERS/PLOTTERS
F267 LUBRICATE IMPACT PRINTERS/PLOTTERS
F268 ADJUST AND ALIGN IMPACT PRINTERS/PLOTTERS
F269 REMOVE AND REPLACE IMPACT PRINTER/PLOTTER COMPONENTS
F270 PERFORM FUNCTIONAL CHECKS ON NON-IMPACT PRINTERS/PLOTTERS (LASER, THERMAL, ETC.)
F271 CLEAN AND INSPECT NON-IMPACT PRINTERS/PLOTTERS
F272 TROUBLESHOOT NON-IMPACT PRINTERS/PLOTTERS
F273 REMOVE AND REPLACE NON-IMPACT PRINTER/PLOTTER COMPONENTS
F274 SET UP DATA INTERFACE PATCH PANELS
F275 SET UP AUTOMATED/MANUAL SWITCHBOARDS
F276 SET UP TACTICAL DATA SYSTEM FOR DUAL OPERATIONAL AND TRAINING MODES (LESSON TRANSLATOR)
F277 MOUNT MAGNETIC DISK PACKS
F278 CHANGE DATA MEDIA (CD ROM/FLOPPY DISKETTE/WORM DISK)
F279 MOUNT MAGNETIC TAPES
F280 MOUNT PAPER TAPES
F281 CHANGE PRINTER RIBBONS
F282 PERFORM SYSTEM BACKUPS
F283 DOCUMENT COMPUTER PROGRAMS
F284 WRITE APPLICATIONS/UTILITY PROGRAMS
F285 DEBUG APPLICATIONS/UTILITY PROGRAMS
F286 FORMAT FLOPPY DISKETTES
F287 COPY FLOPPY DISKETTES
F288 DEGAUSS MAGNETIC TAPES
F289 COPY MAGNETIC TAPES
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F290 VERIFY MAGNETIC TAPES
F291 COPY MAGNETIC DISKS
F292 FORMAT MAGNETIC DISKS
F293 VERIFY MAGNETIC DISKS
F294 INSTALL OPERATIONAL PROGRAM PATCHES
F295 INSTALL SYSTEM PROGRAM UPDATES
F296 INSTALL MICROCOMPUTER SOFTWARE PACKAGES
F298 EVALUATE PROGRAMMED OPERATIONAL AND FUNCTIONAL APPRAISALS (POFA) RESULTS
F299 PERFORM SYSTEM AUDITS (FIELD CHANGES, SHIPALT, ETC.)
F300 EVALUATE AIS SECURITY PLANS
F301 ADMINISTER AIS SECURITY PLANS
F302 DEVELOP ORGANIZATIONAL SOFTWARE PLANS
F305 SUBMIT VIRUS INFECTION INCIDENT REPORTS
F306 DOCUMENT RECEIPT OF CLASSIFIED SOFTWARE
F307 DISPOSE OF CLASSIFIED DATA MEDIA
F308 VERIFY CLASSIFIED DATA MEDIA DESTRUCTION
F309 DEVELOP AIS STANDARD OPERATING PROCEDURES (SOP)
F310 DEVELOP AIS ORGANIZATIONAL DIRECTIVES
F311 REVISE AIS ORGANIZATIONAL DIRECTIVES
F312 REVIEW HARDWARE/SOFTWARE PACKAGE REQUISITIONS
F313 INVENTORY EQUIPMENT SOFTWARE
F315 EVALUATE INADEQUACIES IN OPERATIONAL PROGRAMS
F316 EVALUATE INADEQUACIES IN MAINTENANCE PROGRAMS
F317 SET UP LOCAL AREA NETWORK (LAN)
F318 TROUBLESHOOT LAN
F319 REMOVE AND REPLACE LAN ASSEMBLIES
G. ELECTRICAL/ELECTRONIC MAINTENANCE
G320 TROUBLESHOOT POWER SUPPLIES
G321 ADJUST AND ALIGN POWER SUPPLIES
G322 REPLACE COMPONENTS ON POWER SUPPLIES
G323 TEST AND OPERATE POWER SUPPLIES
G324 EVALUATE PERFORMANCE OF POWER SUPPLIES
G325 CLEAN AND INSPECT POWER SUPPLIES
G326 REPLACE MODULES AND CIRCUIT CARDS ON POWER SUPPLIES

G327 VERIFY THAT EQUIPMENT INTERLOCKS WORK
G328 REPLACE EQUIPMENT LIGHT BULBS
G329 INSPECT EQUIPMENT SHIELDING
G330 REPLACE SWITCHES
G331 INTERPRET MAINTENANCE SCHEMATICS
G332 INTERPRET FUNCTIONALLY ORIENTED MAINTENANCE MANUALS (FOMMS)
G333 INTERPRET FLOW CHARTS
G334 INTERPRET FAULT MATRIX DIAGRAMS
G335 INTERPRET SHIP'S INTEGRATED MAINTENANCE MANUALS (SIMMS)
G336 INSTALL/REPAIR RADIO FREQUENCY (RF) CONNECTORS
G337 INSTALL/REPAIR MULTI-PIN CONNECTORS
G338 PERFORM HAZARDOUS MATERIAL CLEANUP
G339 INSPECT SHOCK MOUNTS
G340 PERFORM FRESH WATER WASH DOWN ON ANTENNAS
G341 TEST CABLE ASSEMBLIES
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G342 REPLACE GASKETS AND "O" RINGS
G343 INSPECT CABLE FEED THROUGH ASSEMBLIES
G344 INSPECT CABLE CONNECTORS (CORROSION, CRACKS, DAMAGED PINS, WEAR, ETC.)
G345 TREAT ELECTRONIC CONNECTORS WITH CORROSION PREVENTATIVES
G346 TURN IN EQUIPMENT FOR CALIBRATION
G347 INSTALL EQUIPMENT FIELD CHANGES
G348 PERFORM ELECTROSTATIC DISCHARGE (ESD) PREVENTION MEASURES WHEN HANDLING SOLID STATE DEVICES
G349 REPLACE CIRCUIT CARDS CONTAINING ELECTROSTATIC DISCHARGE SENSITIVE (ESDS) COMPONENTS
G350 REMOVE ESDS COMPONENTS
G351 REPLACE ESDS COMPONENTS
G352 PACKAGE AND LABEL REPAIRABLES CONTAINING ESDS COMPONENTS
G353 LAYOUT CABLE RUNS
G354 INSPECT RIBBON CABLES
G355 TEST RIBBON CABLES
G356 TROUBLESHOOT RIBBON CABLES
G357 REPAIR RIBBON CABLES
G358 REMOVE AND REPLACE RIBBON CABLES
G359 INSPECT COAXIAL CABLES
G360 TEST COAXIAL CABLES
G361 TROUBLESHOOT COAXIAL CABLES
G362 REPAIR COAXIAL CABLES
G363 REMOVE AND REPLACE COAXIAL CABLES
G364 INSTALL CABLES (EXCLUDING FIBER OPTIC)
G365 REMOVE CABLES
G366 PERFORM COMPONENT LEVEL SOLDERING AND REPAIR (SINGLE SIDED CIRCUIT BOARDS)
G367 PERFORM MANUAL WIRE WRAP CONNECTIONS
G368 PERFORM WIRE WRAP GUN CONNECTIONS
G369 PERFORM TERMI-POINT CONNECTIONS
G370 PERFORM CRIMP CONNECTIONS
G371 PERFORM PIN INSERTION AND EXTRACTION
G372 REMOVE AND REPLACE PRINTED CIRCUIT BOARDS (PCB)
G373 TEST PCB
G374 INSPECT PCB FOR DAMAGE (EXCESSIVE HEAT, COLD SOLDER JOINTS, CORROSION, ETC.)
G375 REMOVE PCB CORROSION
G376 TREAT PCB WITH CORROSION PREVENTATIVES
G377 REMOVE PCB COMPONENTS (NON-MULTILAYER)
G378 REPLACE PCB COMPONENTS (NON-MULTILAYER)
G379 DETERMINE COMPONENT CHARACTERISTICS USING COLOR CODE
G380 DETERMINE COMPONENT VALUES USING COLOR CODE
G381 DETERMINE RESISTANCE USING COLOR CODE
G382 TROUBLESHOOT NORMAL POWER DISTRIBUTION SYSTEMS
G383 TROUBLESHOOT EMERGENCY POWER DISTRIBUTION SYSTEMS
G384 IDENTIFY AND LABEL MULTIPLE POWER SOURCE EQUIPMENT
G385 DISCHARGE ELECTROLYTIC COMPONENTS
G386 DISCHARGE CATHODE RAY TUBES (CRT)
G387 REMOVE AND REPLACE CRT
G388 REPLACE FUSES IN EQUIPMENT
G389 REPLACE CIRCUIT BREAKERS
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G390 TEST FOR GROUNDED CIRCUITS

G391 TEST FOR SHORT-CIRCUITS
G392 TEST FOR CIRCUIT CONTINUITY
G393 TEST AND INSPECT REPAIRED ELECTRONIC CIRCUITS
G394 TEST AND INSPECT REPAIRED ELECTRONIC SUBASSEMBLIES
G395 DEGAUSS MAGNETIC RECORDING DEVICES
G396 PRESERVE INSTALLED CONNECTORS
G397 PERFORM FUNCTIONAL CHECKS ON HANDSETS
G398 CLEAN AND INSPECT HANDSETS
G399 TROUBLESHOOT HANDSETS
G400 REPAIR HANDSETS
G401 TEST HANDSETS
G402 REMOVE AND REPLACE HANDSET COMPONENTS
G403 PERFORM FUNCTIONAL CHECKS ON HEADSETS
G404 INSPECT HEADSETS
G405 TROUBLESHOOT HEADSETS
G406 REPAIR HEADSETS
G407 TEST HEADSETS
G408 REMOVE AND REPLACE HEADSET COMPONENTS
G409 MEASURE ELECTROMAGNETIC INTERFERENCE (EMI)
G410 MEASURE RADIO-FREQUENCY INTERFERENCE (RFI)
G411 CLEAN AND INSPECT EMI PROTECTION CIRCUITS
G412 TEST EMI PROTECTION CIRCUITS
G413 TROUBLESHOOT EMI PROTECTION CIRCUITS
G414 REMOVE AND REPLACE EMI PROTECTION CIRCUIT COMPONENTS
G415 IDENTIFY POSSIBLE SOURCES OF ELECTROMAGNETIC INTERFERENCE (EMI)
(FUNCTIONAL, INCIDENTAL, NATURAL, HULL GENERATED, ETC.)
G416 PERFORM QUALITY ASSURANCE (QA) ELECTRONIC REPAIRS
G417 DISCHARGE COMPONENTS USING SHORTING PROBE
G418 REMOVE AND REPLACE FAULTY CIRCUIT COMPONENTS
G419 INTERPRET POWER DISTRIBUTION DIAGRAMS TO ASSIST IN TROUBLESHOOTING
G420 INSPECT WAVEGUIDE SECTIONS
G421 REPLACE WAVEGUIDE SECTIONS
G422 CONDUCT PRE-TEMPEST INSPECTIONS
G423 INVENTORY ELECTRONIC CASUALTY CONTROL (ECC) REPAIR KITS
G424 PLACE EQUIPMENT IN BATTLE SHORT CONDITION
H. TEST EQUIPMENT
H425 VERIFY CALIBRATION OF TEST EQUIPMENT
H426 VERIFY PROPER OPERATION OF TEST EQUIPMENT
H427 ANALYZE WAVEFORM SIGNAL MEASUREMENTS USING OSCILLOSCOPE
H428 INTERPRET WAVEFORM SIGNAL MEASUREMENTS USING OSCILLOSCOPE
H429 MEASURE CURRENT
H430 MEASURE RESISTANCE
H431 MEASURE VOLTAGE
H432 MEASURE CAPACITANCE AND INDUCTANCE
H433 MEASURE POWER
H434 PERFORM FUNCTIONAL CHECKS ON TEST EQUIPMENT
H435 EVALUATE PERFORMANCE OF TEST EQUIPMENT
H436 MEASURE FREQUENCY
H437 MEASURE TRANSISTOR PERFORMANCE CHARACTERISTICS USING TRANSISTOR
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TESTER
H438 EVALUATE IN-CIRCUIT COMPONENT CONDITIONS USING AN OCTOPUS OR TRACKER
H439 ANALYZE ELECTRONIC COMPONENT SIGNATURES
H440 ANALYZE CIRCUIT BANDWIDTH AND MODULATION
H441 INJECT SIGNALS
H442 IDENTIFY ELECTRONIC COMPONENT CHARACTERISTICS
H443 IDENTIFY ELECTRONIC COMPONENT VALUES
H444 MEASURE TIME DIFFERENTIAL USING A STOPWATCH
H445 MEASURE CHARACTERISTICS OF TRANSMISSION LINES
H446 INJECT SIGNAL USING A SIGNAL GENERATOR
H447 MAKE WAVEFORM COMPARISONS USING A SIGNAL GENERATOR AND OSCILLOSCOPE
H448 DETERMINE OUTPUT FREQUENCY USING A SPECTRUM ANALYZER
H449 DETERMINE MODULATION USING A SPECTRUM ANALYZER
H450 DETERMINE BANDWIDTH USING A SPECTRUM ANALYZER
H451 MEASURE POWER USING ATTENUATORS
H452 ZERO MULTIMETER
H453 MEASURE VOLTAGE STANDING WAVE RATIO ON TRANSMISSION LINES
I. TECHNICAL ADMINISTRATION
I454 INVENTORY CLASSIFIED COMMUNICATION SECURITY MATERIAL SYSTEM (CMS)
MATERIALS

I455 SURVEY EQUIPMENT
I456 UPDATE DOCUMENTATION FOR NEWLY INSTALLED EQUIPMENT
I457 INVENTORY MAINTENANCE ASSISTANCE MODULES (MAMS)
I458 INVENTORY READY SERVICE SPARES (RSS)
J. ELECTRONIC SAFETY
J459 PERFORM ELECTRONIC SAFETY CHECKS ON PERSONAL EQUIPMENT
J460 TEST RUBBER MATTING
J461 INSTALL GROUNDING STRAPS
J462 REPLACE GROUNDING STRAPS
J463 TEST AND INSPECT EQUIPMENT GROUNDING STRAPS
J464 TEST AND INSPECT GROUNDING STRAPS
J465 VERIFY EQUIPMENT STATUS IN EMISSION CONTROL (EMCON) PLAN
J466 PLACE EQUIPMENT IN AN EMISSION CONTROL CONDITION
J467 PLACE EQUIPMENT IN A HAZARDOUS ELECTRONIC RADIATION TO ORDNANCE (HERO) CONDITION
J468 PLACE EQUIPMENT IN A HAZARDOUS ELECTRONIC RADIATION TO FUEL (HERF) CONDITION
J469 DISPOSE OF CRT
J470 EVALUATE HAZARDOUS MATERIAL STORAGE

Figure 27. Occupational Standards ET3[50]

[50] NAVPERS 18068F. Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards. Vol. 1, Navy Enlisted Occupational Standards. January 2004.

APPENDIX B. OCCUPATIONAL STANDARDS FIRE CONTROLMAN THIRD CLASS (FC3)

FIRE CONTROLMAN THIRD CLASS (FC3)
A. ELECTRICAL/ELECTRONIC MAINTENANCE
A001 INSPECT EQUIPMENT SHIELDING
A004 MEASURE ALTERNATING CURRENT (AC)
A005 MEASURE DIRECT CURRENT (DC)
A006 MEASURE ALTERNATING CURRENT (AC) VOLTAGES
A007 MEASURE DIRECT CURRENT (DC) VOLTAGES
A008 MEASURE CIRCUIT RESISTANCE
A009 MEASURE CIRCUIT CAPACITANCE AND INDUCTANCE
A010 MEASURE FREQUENCY
A011 MEASURE POWER
A012 MEASURE TRANSMISSION LINE STANDING WAVE RATIO
A013 TEST FOR GROUNDED CIRCUITS
A014 TEST FOR SHORT-CIRCUITS
A015 TEST FOR CIRCUIT CONTINUITY
A016 ANALYZE CIRCUIT WAVEFORMS
A017 ANALYZE CIRCUIT BANDWIDTH AND MODULATION
A018 INJECT SIGNALS
A019 IDENTIFY ELECTRONIC COMPONENT CHARACTERISTICS/ VALUES
A020 ADJUST AND ALIGN SERVOS
A021 ADJUST AND ALIGN SYNCHROS
A022 TEST EQUIPMENT INTERLOCKS
A023 PERFORM TEST EQUIPMENT PRE-OPERATIONAL CHECKS
A024 REPLACE FAULTY CIRCUIT COMPONENTS
A025 IDENTIFY CIRCUIT CARDS CONTAINING ELECTROSTATIC DISCHARGE SENSITIVE (ESDS) COMPONENTS
A026 REPLACE CIRCUIT CARDS CONTAINING ELECTROSTATIC DISCHARGE SENSITIVE (ESDS) COMPONENTS
A033 REPLACE CIRCUIT CARD ASSEMBLIES (CCA)
A034 TEST AND INSPECT CIRCUIT CARD ASSEMBLIES (CCA) FOR DAMAGE (HEAT, COLD, SOLDER JOINT CORROSION
A035 REMOVE CIRCUIT CARD ASSEMBLIES (CCA) CORROSION
A036 TREAT CIRCUIT CARD ASSEMBLIES (CCA) WITH CORROSION PREVENTATIVES
A037 TEST AND INSPECT REPAIRED ELECTRONIC CIRCUITS/SUBASSEMBLIES
A039 INSPECT CABLE CONNECTORS (CORROSION, CRACKS, DAMAGED PINS, WEAR)
A040 WEATHERPROOF EXTERIOR CABLE CONNECTIONS
A041 TREAT ELECTRONIC CONNECTORS WITH CORROSION PREVENTATIVES
A042 TEST CABLE CONNECTORS
A043 TROUBLESHOOT CABLE CONNECTORS
A044 REPLACE CABLE CONNECTORS
A045 TEST AND INSPECT RIBBON CABLES
A046 TROUBLESHOOT RIBBON CABLES
A047 REPLACE RIBBON CABLES
A048 TEST AND INSPECT COAXIAL CABLES
A049 TROUBLESHOOT COAXIAL CABLES
A050 REPAIR COAXIAL CABLES
A051 REPLACE COAXIAL CABLES
A055 MAINTAIN AND OPERATE LOW/ HIGH VOLTAGE POWER SUPPLY COMPONENTS
A058 TEST ELECTRONIC MAGNETIC INTERFERENCE (EMI) PROTECTION CIRCUITS
A062 ADJUST AND ALIGN VIDEO MONITORS
A069 IDENTIFY AND LABEL MULTIPLE POWER SOURCE EQUIPMENT
A070 DISCHARGE ELECTROLYTIC COMPONENTS
A072 REPLACE CATHODE RAY TUBES (CRT)
A074 INSPECT RUBBER MATTING
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A075 TEST AND INSPECT EQUIPMENT GROUNDING STRAPS
A076 REPLACE EQUIPMENT GROUNDING STRAPS
A077 PLACE EQUIPMENT IN A HAZARD FROM ELECTROMAGNETIC RADIATION TO ORDNANCE (HERO) HIGH ENERGY RECEIVER FREQUENCY (HERF) CONDITION
A078 INVENTORY MAINTENANCE ASSISTANCE MODULES (MAMS)
A519 TEST FIBER OPTIC CABLES
B. ELECTRONIC SUPPORT EQUIPMENT

B089 CLEAN, INSPECT, AND ALIGN ELECTRONIC EQUIPMENT LIQUID COOLING SYSTEMS (EELCS) COMPONENTS
B090 LUBRICATE ELECTRONIC EQUIPMENT LIQUID COOLING SYSTEMS (EELCS) COMPONENTS
B091 PURGE ELECTRONIC EQUIPMENT LIQUID COOLING SYSTEMS (EELCS)
B092 REPLACE ELECTRONIC EQUIPMENT LIQUID COOLING SYSTEMS (EELCS) PUMPS
B093 REPLACE ELECTRONIC EQUIPMENT LIQUID COOLING SYSTEMS (EELCS) FILTERS
B095 REPLACE ELECTRONIC EQUIPMENT LIQUID COOLING SYSTEMS (EELCS) REGULATING VALVES
B097 REPLACE ELECTRONIC EQUIPMENT LIQUID COOLING SYSTEMS (EELCS) SALINITY CELLS
B098 REPLACE ELECTRONIC EQUIPMENT LIQUID COOLING SYSTEMS (EELCS) TEMPERATURE CELLS
B099 REPLACE ELECTRONIC EQUIPMENT LIQUID COOLING SYSTEMS (EELCS) GUAGES
B100 TEST ELECTRONIC EQUIPMENT LIQUID COOLING SYSTEMS (EELCS) ALARMS
B104 CLEAN AND INSPECT SEA STRAINERS
B106 REPLACE HEAT EXCHANGERS AND ASSOCIATED COMPONENTS
B108 PERFORM FUNCTIONAL CHECKS ON TEMPERATURE/HUMIDITY RECORDERS
B116 ADJUST AND ALIGN ELECTRONIC FREQUENCY CONVERTERS
B133 PERFORM FUNCTIONAL CHECKS ON DRY AIR SYSTEMS
B136 CLEAN, INSPECT, AND ADJUST DEHYDRATORS
B139 REPLACE COMPRESSED GAS BOTTLES
B140 CLEAN, INSPECT, AND REPLACE WAVEGUIDE ASSEMBLIES
B144 REPLACE AND ADJUST POWER CONTROL DEVICES
B391 VERIFY CALIBRATION OF TEST EQUIPMENT
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C145 PERFORM ALTERNATE BUS TRANSFERS
C146 PERFORM COOLING SYSTEM ALIGNMENTS (CASUALTY/NORMAL)
C147 PLACE EQUIPMENT IN BATTLE SHORT CONDITION
C148 PLACE COMBAT SYSTEMS EQUIPMENT IN CASUALTY MODE
D. ELECTRONIC HAZARDOUS MATERIAL CONTROL
D152 REVIEW MATERIAL SAFETY DATA SHEETS (MSDS)
D153 REVIEW HAZARDOUS MATERIAL USER'S GUIDE (HMUG)
D154 REVIEW HAZARDOUS MATERIAL (HAZMAT) INVENTORIES
D155 INSPECT HAZARDOUS MATERIAL (HAZMAT) STORAGE AREAS
D156 EVALUATE HAZARDOUS MATERIAL (HAZMAT) STORAGE
D157 IMPLEMENT HAZARDOUS MATERIAL (HAZMAT) WASTE DISPOSAL METHODS
D158 CLEAN AND INSPECT HAZARDOUS MATERIAL (HAZMAT) CONTAINERS
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E. COMPUTER AND PERIPHERAL MAINTENANCE
E159 CONFIGURE SYSTEM FOR DIRECT SYSTEM OPERABILITY TESTS (DSOT)/ OVERALL COMBAT SYSTEM OPERABILITY TESTS (OCSOT)
E160 MONITOR DIRECT SYSTEM OPERABILITY TESTS (DSOT)/ OVERALL COMBAT SYSTEM OPERABILITY TESTS (OCSOT)
E161 RECORD DIRECT SYSTEM OPERABILITY TESTS (DSOT)/ OVERALL COMBAT SYSTEM OPERABILITY TESTS (OCSOT) RESULTS
E162 COORDINATE DIRECT SYSTEM OPERABILITY TESTS (DSOT)/ OVERALL COMBAT SYSTEM OPERABILITY TESTS (OCSOT) TESTING
E166 LOAD PROGRAMMED OPERATIONAL AND FUNCTIONAL APPRAISALS (POFA)
E172 LOAD MAINTENANCE TEST PROGRAMS (MTP)/STANDARD TEST PROGRAMS (STP)
E173 MONITOR MAINTENANCE TEST PROGRAMS (MTP)/STANDARD TEST PROGRAMS (STP)
E174 RECORD MAINTENANCE TEST PROGRAMS (MTP)/STANDARD TEST PROGRAMS (STP) RESULTS
E175 ANALYZE MAINTENANCE TEST PROGRAMS (MTP)/STANDARD TEST PROGRAMS (STP) RESULTS
E176 LOAD DIAGNOSTIC PROGRAMS
E177 MONITOR DIAGNOSTIC PROGRAMS
E178 RECORD DIAGNOSTIC PROGRAM RESULTS
E179 ANALYZE DIAGNOSTIC MAINTENANCE RESULTS
E180 EVALUATE INTERFACE OPERATIONS
E181 DIAGNOSE DIGITAL DATA SYSTEM MALFUNCTIONS
E186 CLEAN, INSPECT, AND ADJUST VIDEO PROCESSORS
E193 CLEAN, INSPECT, AND REPLACE COMPUTER MAINTENANCE PANEL COMPONENTS
E211 CLEAN, INSPECT, AND REPLACE MAGNETIC TAPE UNITS (MTU)
E217 CLEAN, INSPECT, AND REPLACE MAGNETIC TAPE CONTROLLERS
E223 CLEAN, INSPECT, AND REPLACE INPUT/OUTPUT (I/O) CONSOLES
E228 CLEAN, INSPECT, AND REPLACE DATA DISPLAY CONSOLES
E232 PERFORM FUNCTIONAL CHECKS ON WEAPONS/ENGAGEMENT CONTROL CONSOLES

E233 CLEAN, INSPECT, AND REPLACE WEAPONS/ENGAGEMENT CONTROL CONSOLES
E238 CLEAN AND INSPECT VIDEO TERMINALS
E244 CLEAN, INSPECT, AND REPLACE PRINTERS/PLOTTERS
E264 PERFORM FUNCTIONAL CHECKS ON SIGNAL/DATA CONVERTERS
E265 CLEAN, INSPECT, AND REPLACE SIGNAL/DATA CONVERTERS
F. COMPUTER SYSTEMS OPERATIONS
F269 LOAD SYSTEM AND OPERATIONAL PROGRAMS
F270 MONITOR SYSTEM AND OPERATIONAL PROGRAMS
F276 MOUNT MAGNETIC TAPES
G. WEAPONS HANDLING/MAINTENANCE
G293 VERIFY WEAPON AND COMPONENT LIFE SPANS
G294 CAN AND UNCAN WEAPONS AND COMPONENTS
G295 INSPECT WEAPON CONTAINERS
G296 INSPECT WEAPON COMPONENT CONTAINERS
G297 ON-LOAD WEAPONS AND COMPONENTS
G298 OFF-LOAD WEAPONS AND COMPONENTS
G299 STOW WEAPONS AND COMPONENTS
G301 OPERATE WEAPON HANDLING EQUIPMENT
G303 PERFORM FUNCTIONAL CHECKS ON WEAPON VENTILATION SYSTEMS
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H. COMBAT DIRECTION/WEAPONS DIRECTION/FIRE CONTROL SYSTEMS MAINTENANCE
H307 CONDUCT BENCHMARK CHECKS
H308 CONDUCT TRANSMISSION CHECKS
H309 VERIFY AND RECORD BENCHMARK READINGS/TRAM ELEMENTS/DATA
H310 PERFORM DYNAMIC ACCURACY TESTS ON GUN FIRE CONTROL (GFC)
H314 PERFORM SEARCH RADAR ALIGNMENTS AND TRACK ACCURACY
H315 PERFORM RELATIVE TRACK ALIGNMENTS
H316 PERFORM FUNCTIONAL CHECKS/TARGET DESIGNATION TRANSMITTERS (TDT)
H317 CLEAN, INSPECT, AND ALIGN TARGET DESIGNATION TRANSMITTERS (TDT)
H322 CLEAN, INSPECT, AND ADJUST TRACKING RECEIVER COMPONENTS
H327 CLEAN, INSPECT, AND ADJUST TRACKING TRANSMITTER COMPONENTS
H332 CLEAN, INSPECT, AND ADJUST CONTINUAL WAVE ILLUMINATION (CWI) TRANSMITTER COMPONENTS
H341 COLLIMATE RADARS
H342 INTERPRET DISPLAY SYMBOLOGY
H493 PERFORM BATTERY ALIGNMENTS
I. COMBAT DIRECTION/WEAPONS DIRECTION/FIRE CONTROL SYSTEMS OPERATIONS
I149 VERIFY EQUIPMENT STATUS IN EMISSIONS CONTROL (EMCON) PLANS
I150 PLACE EQUIPMENT IN EQUIPMENT STATUS IN EMISSIONS CONTROL (EMCON) CONDITION
I151 MONITOR EQUIPMENT STATUS IN EMISSIONS CONTROL (EMCON) COMPLIANCE
I343 PERFORM PRE-FIRE CHECKS
I344 PERFORM WEAPONS SELF-TESTS
I345 PERFORM WEAPON IDENTIFICATION CHECKS
I346 RECONFIGURE FOR DEGRADED WEAPON SYSTEMS
I347 VALIDATE CALIBRATION GO
I348 MANUALLY TRACK TARGETS
I349 VERIFY COAST MODE
I350 IDENTIFY AIR/SURFACE TARGET VIDEO CHARACTERISTICS
I351 ADJUST RADAR PRESENTATIONS
I353 SELECT TARGET FOR ACQUISITION
I354 DESIGNATE FIRE CONTROL RADARS
I355 AID IN TARGET ACQUISITION
I357 EVALUATE TARGET THREAT PARAMETERS
I358 OPTIMIZE TARGET TRACKS
I360 IDENTIFY VIDEO SEPARATION
I361 ASSIGN LAUNCHER
I362 SELECT MISSILES
I363 ASSIGN MISSILES
I364 VERIFY GUN/MISSILE ORDERS
I365 DESTROY MISSILES IN FLIGHT
I366 INPUT ENVIRONMENTAL CONDITIONS (AIR DENSITY, TEMPERATURE, ETC)
I367 INPUT PROJECTILE WEIGHT/TEMPERATURE
I369 VERIFY BALLISTIC SOLUTIONS
I370 ASSIGN GUNS
I371 VERIFY CONTROL OF DIRECTORS
I372 VERIFY READY TO FIRE
I373 CLOSE FIRING CIRCUITS
I374 VERIFY WEAPON AWAY
I375 VERIFY ROUNDS FIRED

I376 EVALUATE ACCURACY OF ROUNDS
I377 APPLY TARGET AND ROUND SPOTTING
I378 VERIFY WEAPON INTERCEPT
I379 INITIATE DUD FIRE
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I380 IDENTIFY GUN MISFIRES
I382 PLACE GUN MOUNT IN SAFE FIRE POSITION
I383 PERFORM POST-FIRE CHECKS
J. COMBAT SYSTEM READINESS ASSESSMENT
J462 UPDATE COMBAT SYSTEMS SMOOTH LOGS
K. ELECTRONIC SYSTEMS MANAGEMENT
K463 ANALYZE MAINTENANCE DATA
L. RADAR MAINTENANCE
L395 CLEAN AND INSPECT ANTENNA CONTROL SYSTEMS
L403 CLEAN, INSPECT, AND ADJUST RADAR RECEIVER COMPONENTS
L408 CLEAN, INSPECT, AND ADJUST RADAR TRANSMITTER COMPONENTS
L412 PERFORM FUNCTIONAL CHECKS ON TRIGGER/PULSE AMPLIFIERS
L413 CLEAN AND INSPECT TRIGGER/PULSE AMPLIFIERS
L414 ADJUST AND ALIGN TRIGGER/PULSE AMPLIFIERS
L415 TROUBLESHOOT TRIGGER/PULSE AMPLIFIERS
L416 REPLACE TRIGGER/PULSE AMPLIFIER COMPONENTS
L418 ADJUST AND REPLACE KLYSTRON AMPLIFIERS AND TUBES
L425 ADJUST AND REPLACE TRAVELING WAVE TUBE (TWT)/MAGNETRON AMPLIFIERS
L430 CLEAN, INSPECT, AND REPLACE RECTIFIER UNITS
L434 CLEAN AND INSPECT RADOMES
L435 REPLACE RADOMES
L437 CLEAN, INSPECT, AND REPLACE RADAR ANTENNAS
L442 CLEAN, INSPECT, AND ADJUST STABILIZATION EQUIPMENT
L445 CLEAN, INSPECT, AND REPLACE ELEVATION AND TRAIN MOTORS
L520 MAINTAIN AND OPERATE CROSS-FIELD AMPLIFIERS

Figure 28. Occupational Standards FC3[51]

[51] NAVPERS 18068F. Manual of Navy Enlisted Manpower and Personnel and Classifications and Occupational Standards. Vol. 1, Navy Enlisted Occupational Standards. January 2004

APPENDIX C. OCCUPATIONAL STANDARDS FIRE CONTROL TECHNICIAN THIRD CLASS (FT3)

FIRE CONTROL TECHNICIAN THIRD CLASS (FT3)
A. TACTICS
A002 PERFORM TORPEDO TUBE LAUNCHING SYSTEM (TTLS) EQUIPMENT TRANSMISSION CHECKS
A004 EMPLOY FIRE CONTROL SYSTEM (FCS) IN TARGET MOTION ANALYSIS (TMA) MODES
A005 EMPLOY COMBAT CONTROL SYSTEMS (CCS) IN WEAPONS CONTROL MODES
A006 COMPUTE TORPEDO PRESETS
A007 ASSIGN TORPEDO PRESETS
A008 ENTER TORPEDO PRESETS
A010 COMPUTE MISSILE PRESETS
A011 ASSIGN MISSILE PRESETS
A012 ENTER MISSILE PRESETS
A015 LAUNCH WEAPONS IN ALL LAUNCH MODES
A016 DETERMINE TARGET PARAMETERS USING CONTACT EVALUATION PLOT (CEP)
A017 DETERMINE TARGET PARAMETERS USING TIME RANGE PLOT
A018 DETERMINE TARGET PARAMETERS USING TIME FREQUENCY PLOT
A019 DETERMINE TARGET PARAMETERS USING GEOGRAPHIC (GEO) PLOT
A020 DETERMINE TARGET PARAMETERS USING TIME BEARING (T/B) PLOT
A023 PERFORM OVER THE HORIZON-TARGETING (OTH-T) COMMUNICATIONS
A026 PERFORM OVER THE HORIZON-TARGETING (OTH-T) MANUAL PLOTTING
A027 MAINTAIN OVER THE HORIZON (OTH) DATABASE
A028 PREPARE OVER THE HORIZON (OTH) COMMUNICATIONS MESSAGES
A030 ENTER COUNTERMEASURES PRESETS
A031 LAUNCH COUNTERMEASURES
A032 PERFORM TORPEDO SNAPSHOT MODE ATTACKS
A033 PERFORM LINK OPERATIONS
A036 DETERMINE EFFECTS OF SUBMARINE EXPENDABLE BATHYTHERMOGRAPH (SSXBT) DATA
A037 EMPLOY OPTICAL EQUIPMENT
A038 PERFORM TARGET MOTION ANALYSIS (TMA)
A040 RECOMMEND SHIP'S MANEUVERS TO PROSECUTE A CONTACT OF INTEREST
A041 PERFORM WEAPONS CASUALTY LAUNCHES
A042 UPDATE TOMAHAWK COMMAND INFORMATION
A043 PERFORM MISSION DATA UPDATE (MDU) OPERATIONS IN ALL MODES
A046 PERFORM CAPSULE LAUNCHING SYSTEM (CLS) OPERATION TESTS
A057 RECOMMEND EVASION TACTICS
A058 PERFORM TOMAHAWK ENGAGEMENT PLANNING
A059 PERFORM TORPEDO ENGAGEMENT PLANNING
A115 PERFORM COMBAT CONTROL SYSTEM (CCS) WEAPONS TRANSMISSION CHECKS
A160 INTERPRET FIRE CONTROL PLOTS
A236 PERFORM TOMAHAWK LAND ATTACK MISSILE (TLAM) COMMANDING OFFICER (CO) BATTLE READINESS TESTS
B. WEAPONS HANDLING
B061 PERFORM WEAPONS ONLOAD
B062 PERFORM WEAPONS OFFLOAD
B063 PERFORM PYROTECHNICS ONLOAD
B064 PERFORM PYROTECHNICS OFFLOAD
B065 PERFORM COUNTERMEASURES ONLOAD
B066 PERFORM COUNTERMEASURES OFFLOAD
B069 PERFORM CAPSULE LAUNCHING SYSTEM (CLS) PRE-LOADOUT CHECKS
FT-4
D. MECHANICAL SYSTEM MAINTENANCE
D078 CLEAN, INSPECT AND LUBRICATE MECHANICAL EQUIPMENT
D080 ADJUST AND ALIGN MECHANICAL EQUIPMENT
D081 CHECK MECHANICAL INTERLOCKS
D083 REMOVE AND INSTALL TORPEDO TUBE LAUNCHING SYSTEM (TTLS) EQUIPMENT COMPONENTS
D092 INSPECT ELECTRONIC COOLING SYSTEMS (ECS)
D266 PERFORM CAPSULE LAUNCHING SYSTEM (CLS) OPERATIONAL TESTS
D267 PERFORM TORPEDO TUBE LAUNCHING SYSTEM (TTLS) OPERATIONAL TESTS
E. ELECTRICAL/ELECTRONIC TROUBLESHOOTING
E093 INSPECT ELECTRICAL INTERLOCKS
E094 INSPECT ELECTRICAL CABLE AND CONNECTOR ASSEMBLIES

E095 REMOVE, REPAIR AND INSTALL ELECTRICAL CABLE AND CONNECTOR ASSEMBLIES
E132 REMOVE AND INSTALL COMBAT CONTROL SYSTEM (CCS) EQUIPMENT COMPONENTS AND MODULES
E139 TEST COMBAT CONTROL SYSTEM (CCS) TEST EQUIPMENT
E142 MONITOR COMBAT CONTROL SYSTEM (CCS) SYSTEM STATUS
E147 VERIFY COMBAT CONTROL SYSTEM (CCS) ALIGNMENTS
E148 REMOVE, INSPECT AND INSTALL COMBAT CONTROL SYSTEM (CCS) CABLES
E153 TEST FOR CIRCUIT CONTINUITY/PING
E155 TEST FOR SHORT CIRCUITS
E156 PERFORM SOLDERING AND DESOLDERING
E157 CLEAN AND INSPECT ELECTRONIC EQUIPMENT
E158 ADJUST AND ALIGN ELECTRONIC EQUIPMENT
E159 PERFORM SYSTEM ALIGNMENT PROCEDURES
E234 OPERATE GENERAL PURPOSE TEST EQUIPMENT (GPETE)
E235 OPERATE SPECIAL PURPOSE TEST EQUIPMENT (SPETE)
F. COMBAT SYSTEM OPERATIONS
F001 PERFORM TORPEDO TUBE LAUNCHING SYSTEM (TTLS) EQUIPMENT DAILY SYSTEMS OPERATIONS TEST (DSOT)
F050 INTERPRET COMBAT CONTROL SYSTEM (CCS) ALERTS AND MODE MESSAGES
F098 PERFORM PRESSURE VENT CONTROL (PVC) CHECKS
F099 PERFORM SYSTEM OPERABILITY TESTS
F101 PERFORM COMBAT CONTROL SYSTEM (CCS) EQUIPMENT OPERATIONAL TESTS
F102 INTERPRET TACTICAL NON-FIRE CONTROL DEVICE DISPLAYS
F103 INTERPRET AUXILIARY SONAR VISUAL DISPLAY UNIT (ASVDU) AND MONITORING SUBSYSTEM (MS) DATA DISPLAYS
F105 EMPLOY FIRE CONTROL SWITCHBOARDS
F106 EMPLOY TARGET BEARING TRANSMITTERS
F107 EMPLOY FIRE CONTROL PLOTTER EQUIPMENT
F108 PERFORM COMBAT SYSTEM INTERFACE TESTING
F109 PERFORM SHIP'S DATA INTERFACE TESTS
F110 PERFORM COMBAT CONTROL SYSTEM (CCS) CASUALTY MODE OPERATIONS
F111 PERFORM WEAPONS PRESET TESTS
F112 PERFORM FAULT INDICATION TESTS
F116 PERFORM MONITORING SUB-SYSTEM OPERATIONS
F117 PERFORM FIRING CRAFT OPERATION PROCEDURES
F118 ANNOTATE WEAPON SYSTEMS TEST DATA
F121 PERFORM SUBMARINE TACTICAL DATA LINK (STDL) OPERATIONS
F123 OPERATE FIRE CONTROL SYSTEMS
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F124 PERFORM RETARGETING OPERATIONS IN ALL MODES
F126 ANALYZE COMBAT CONTROL SYSTEM (CCS) INTERFACE TEST DATA
F128 PERFORM COMBAT CONTROL SYSTEM (CCS) OPERATIONAL EVALUATION TESTS
F129 PERFORM WEAPONS FIRING SEQUENCE TESTS
F232 PERFORM TOMAHAWK LAND ATTACK MISSILE (TLAM) DSMAC FLIGHT SOFTWARE/GLOBAL POSITIONING SYSTEM FLIGHT SOFTWARE (DFS/GFS) DOWNLOAD
F233 PERFORM TOMAHAWK LAND ATTACK MISSILE (TLAM) MODE 7 CONFIDENCE TESTS
G. OPTICAL SYSTEMS
G171 TEST OPTICAL EQUIPMENT
G173 PERFORM PERISCOPE BENCHMARK AND BEARING TRANSMISSION TESTS
G174 VERIFY TARGET BEARING TRANSMITTER OUTPUT ACCURACY
H. TECHNICAL ADMINISTRATION
H175 DRAFT PROGRAM TROUBLE REPORTS
H181 UPDATE FIRE CONTROL LOGS
H182 ANALYZE FIRE CONTROL LOG DATA
H192 ANALYZE WEAPON SYSTEMS TEST DATA
H194 PERFORM TOMAHAWK COMMAND INFORMATION (TCI) MAINTENANCE
H199 COLLECT DATA DURING WEAPONS COMMAND

Figure 29. Occupational Standards FT3[52]

[52] NAVPERS 18068F. Manual of Navy Enlisted Manpower and Personnel and Classifications and Occupational Standards. Vol. 1, Navy Enlisted Occupational Standards. January 2004.

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